CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice (Core)

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

General comments

The majority of candidates successfully selected the correct responses. Candidates performed very well on **Question 25**.

Candidates found **Questions 23** and **26** challenging.

In the physics section only **Question 33** was found to be particularly challenging.

Comments on specific questions

Question 1

While the majority of candidates correctly selected excretion as a characteristic of all living things, a substantial number selected breathing, suggesting that they were not including plants in their living things.

Question 3

Candidates appeared to understand the effects of pH on enzymes better than the effects of temperature, since they chose 20 °C as a suitable temperature for enzymes in thermophilic bacteria. This suggests that they have been informed that all enzymes work better below a certain temperature (probably around 40 °C).

Question 4

Slightly more candidates chose the incorrect answer of glycerol as a component of glycogen rather than fats.

Question 10

While almost all candidates correctly stated that ova and sperms are haploid, a substantial number believed that the zygote was also haploid until after its first division.

Question 12

In this question candidates confused respiration and photosynthesis when asked to interpret a carbon cycle diagram.

Question 14

Stronger candidates chose the incorrect **C** more often than the correct answer, **B**. They are expected to be able to recognise and distinguish diagrams of molecules and of isolated atoms.

Question 16

Some stronger candidates chose the incorrect **B**. Other candidates chose the incorrect **C** more often than the correct answer, **A**. They knew that simple covalent solids do not conduct electricity, but they were unclear about the conductivity of simple covalent liquids and also about their boiling points.

Question 17

Stronger candidates tended to choose the incorrect **C** in preference to the correct answer, **D**. They need to be aware that electrolysis produces simpler substances and to recognise the term *complex*.

Question 19

Candidates chose the incorrect **D** more often than the correct answer, **B**. They need to recognise that these two options involved a comparison of the surface areas of the same mass of zinc.

Question 20

Many candidates found this question challenging. Some stronger candidates thought reactions in the incorrect **A** and **B** were redox. They needed to recognise that elemental oxygen itself is not lost from the initial calcium compounds.

Question 23

Candidates chose the incorrect **C** more often than the correct answer, **A**. They need to know that calcium is more reactive than magnesium and that so reacts faster with dilute hydrochloric acid.

Question 25

Candidates knew very well that oxygen and water are required for rusting.

Question 26

Candidates chose the incorrect **A** more often than the correct answer, **B**. They may have confused the use of ammonium nitrate as a fertiliser with the basic nature of ammonia.

Question 27

Many candidates found this question challenging. Candidates needed to realise that both ethanol formation and its combustion were referred to in this question.

Question 28

In this question on speed-time graphs a large proportion of candidates opted for **D**, this being exactly the same shape as the distance-time graph given in the question.

Question 30

Many weaker candidates believed that the heavy block and larger diameter rod would cause the greatest pressure (option **A**). Candidates need to understand the link between pressure and area.

Question 33

The topic here was thermal expansion. A large proportion of candidates thought that heating either the axle only, or heating both the axle and the wheel, would have the desired effect. Candidates need to ensure that they understand both thermal expansion and the converse effect; the idea of cooling one part so that it would contract.

Question 36

Here the majority of candidates opted for **B**, making the common mistake of not double the distance to the building in order to find the distance travelled by the sound.

Question 38

In this question on the use of an ammeter both incorrect options **B** and **C** were very popular.

Question 39

A number of the weaker candidates believed that the fuse should be connected across the lamp (diagram 1).

Question 40

In this question on background radiation the majority of candidates opted for **B** or **C**.

CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice (Core)

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

General comments

The majority of candidates successfully selected the correct responses.

Candidates performed very well on **Question 21**.

Physics questions **29**, **35**, **37** and **38** were all found very challenging by many candidates.

Comments on specific questions

Question 4

There was a fairly even spread of answers to this question on the digestive system, almost equal numbers of candidates believing that the pancreas absorbed water as the correct answer of the colon. Many got all three functions incorrect.

Question 6

The majority of candidates wrongly chose the pulmonary artery as the vessel carrying blood to the liver. Candidates need to ensure that they know the direction of the different blood vessels and have knowledge about the destruction of hormones.

Question 11

Although a significant number of the candidates correctly selected the correct answer here, substantial numbers did not. Candidates should ensure that they understand genetic terms such as homozygous / heterozygous, and dominant / recessive. A simple Punnett square should have provided them with the correct response.

Question 12

In this question candidates confused respiration and photosynthesis when asked to interpret a carbon cycle diagram.

Question 14

Candidates need to be able to recognise and distinguish diagrams of molecules and of isolated atoms.

Question 16

Stronger candidates tended to choose the incorrect **B** rather than the correct answer, **C**. Candidates should know the required reactions of metals and of acids as specified in the syllabus.

Question 18

Candidates chose the incorrect **B** and **C** more often than the correct answer, **D**. Candidates need to be able to describe the electroplating of metals using laboratory apparatus.

Question 19

Candidates chose the incorrect **B** more often than the correct answer, **A**. They need to be able to describe the chemical reaction involved in the manufacture of lime from calcium carbonate.

Question 20

Stronger candidates chose the incorrect **D** rather than the correct answer, **B**. They need to understand that these two options involved a comparison of the surface areas of the same mass of zinc.

Question 21

Candidates had no difficulty in interpreting the litmus test observations.

Question 23

Stronger candidates chose the incorrect **D** rather than the correct answer, **A**. They need to be able to describe the use of carbon in the extraction some metals from their ores.

Question 26

Candidates are expected to know the uses of lime and that its chemical name is calcium oxide.

Question 28

In this question on speed-time graphs the majority of the candidates opted for **D**, this being exactly the same shape as the distance-time graph given in the question.

Question 29

Candidates found this question very challenging. Many candidates believed that there would be a resultant force acting in the direction of movement, and even more thought that this force would be acting in the opposite direction.

Question 32

The topic here was thermal expansion. A large proportion of candidates thought that heating either the axle only, or heating both the axle and the wheel, would have the desired effect. Candidates need to ensure that they understand thermal expansion and its converse effect; the idea of cooling one part so that it would contract.

Question 34

As a familiar ray diagram for students, option **B** was popular, but did not show an image being formed.

Question 35

The great majority of candidates were unsure of the properties of electromagnetic waves. A majority thought that microwaves had smaller wavelengths than X-rays, and many thought microwaves to be more highly ionising.

Question 37

Although it was widely known that iron is used as the core of an electromagnet, the majority believed that this is because it becomes a permanent magnet.

Question 38

This standard circuit to determine the resistance of a resistor was familiar to a minority of candidates.

Question 39

Many candidates of all abilities thought that the fuse should be connected across the lamp (diagram 1).

Question 40

The circular pattern of the magnetic field around a wire was very well known, but the spacing of the field lines was less familiar.

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Paper 0654/13
Multiple Choice (Core)

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

General comments

The majority of candidates successfully selected the correct responses.

In the physics section **Question 36** was very well answered, but candidates found **Questions 28**, **38** and **39** very challenging.

Comments on specific questions

Question 6

The majority of candidates wrongly chose the pulmonary artery as the vessel carrying blood to the liver. Candidates need to ensure that they know the direction of the different blood vessels and know about the destruction of hormones.

Question 8

Few candidates chose the correct response of gravity causing a plant root to grow downwards, the majority believing it to be lack of water, or possibly light on the leaves.

Question 14

Candidates are expected to be able to recognise and distinguish diagrams of molecules and of isolated atoms.

Question 15

Candidates chose the incorrect **C** more often than the correct answer, **D**. They need to be able to recognise and describe both distillation and fractional distillation as methods of separating mixtures.

Question 19

Candidates chose the incorrect **D** more often than the correct answer, **B**. They need to understand that these two options involved a comparison of the surface areas of the same mass of zinc.

Question 21

Candidates chose the incorrect **B** more often than the correct answer, **C**. Stronger candidates tended to choose the incorrect **A**. They need to know that magnesium oxide is basic and so reacts with dilute acids, and that in this process the acids are neutralised. They should also know that the oxides of the non-metals are acidic and so do not neutralised acids.

Question 22

Candidates chose the incorrect **B** more often than the correct answer, **A**. Candidates need to know the properties of the collection of metals known as the transition elements, as well as some properties of transition element compounds.

Question 26

Candidates chose the incorrect **A** more often than the correct answer, **B**. Stronger candidates tended to choose the incorrect **C**. They need to know the uses of lime and that its chemical name is calcium oxide.

Question 28

In this question on speed-time graphs more than half of the candidates opted for **D**, this being exactly the same shape as the distance-time graph given in the question. Another popular choice was **B**.

Question 32

The topic here was thermal expansion. A large proportion of candidates thought that heating the axle only would have the desired effect. Candidates need to understand thermal expansion and its converse effect; the idea of cooling one part so that it would contract.

Question 34

A minority of candidates chose the correct option in this question on the converging lens, but many of the strongest thought that the image would be smaller than the object. They need to be aware that point Y marked the end of the image.

Question 37

A significant number of candidates of all abilities thought that the fuse should be connected across the lamp (diagram 1).

Question 38

Most candidates found this question, on resistors in parallel, very challenging; with a majority choosing option **D**, the value for resistors in series.

Question 39

Few candidates chose the correct option **D**; the majority believed that the direction would reverse (option **A**).

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Paper 0654/21
Multiple Choice (Extended)

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

General comments

The majority of candidates successfully selected the correct responses.

Candidates performed very well on **Question 19**.

Question 25 proved most challenging for candidates.

Questions 36 and **39** were found the most taxing in the physics section.

Comments on specific questions

Question 4

Almost equal numbers of candidates chose the correct response of transpiration, and the incorrect response of active transport. They need to be clear what constitutes active transport.

Question 5

Responses here were fairly evenly divided over three answers. Two of these had correct parts, but were incorrect overall. Candidates must read the question carefully, which will allow them to disregard the distractors rather than simply focussing on one correct aspect.

Question 12

In this question candidates confused respiration and photosynthesis when asked to interpret a carbon cycle diagram.

Question 17

Stronger candidates chose the incorrect **D** more often than the correct answer, **C**. They need to be able to calculate the number of moles in a mass, in a volume gas and in a volume of solution of known concentration.

Question 19

Candidates understood well the changes associated with the combustion of a fuel.

Question 21

Although many candidates chose the correct answer, **B**, it appears that these candidates may have thought that a Group VI element forms its ions by the addition of only one electron to each atom, instead of two electrons.

Question 23

Stronger candidates chose the incorrect **A** more often than the correct answer, **C**. They need to know that the source of hydrogen for the Haber process is hydrocarbons or steam, and that nitrogen is obtained from the air.

Question 25

Candidates chose the incorrect **C** and **D** more often than the correct answer, **A**. The essential conditions, which they need to know, include the pressure, between 1-2 atmospheres, and the catalyst used, vanadium pentoxide (vanadium(V) oxide, V_2O_5). Most candidates incorrectly thought that a pressure of 200 atmospheres is used.

Question 27

Some of the stronger candidates chose the incorrect **C** rather than the correct answer, **B**. They need to know the structure of nylon, as illustrated in the syllabus.

Question 28

The most common error in answering this question about a speed-time graph was to multiply the final speed by the final time to give option **D**.

Question 29

A large majority of candidates realised that the man would fall forwards, but there was a tendency for them to believe that the property resisting the change in motion was weight rather than mass.

Question 30

This question concerned gravitational potential and kinetic energies, and the incorrect option **D** was chosen by a sizeable minority of candidates. This was possibly as a result of halving the value calculated for speed squared rather than finding its square root.

Question 33

The topic here was thermal expansion. A large proportion of candidates thought that heating the axle only would have the desired effect. They need to be familiar with the idea of cooling one part so that it would contract.

Question 35

A large number of candidates here did not divide their correctly calculated value for wavelength by 4.

Question 36

Candidates need to ensure that they are familiar with, and understand, the image formed by a converging lens. The correct option **D** was the least popular choice.

Question 37

It was widely known that a compression is the name given to a region of higher pressure, but a significant number of weaker candidates in particular thought the waves to be transverse.

Question 39

In this combination of resistors in series and parallel the majority of all candidates opted for **C**, the value obtained if the 6.0 V is considered to be applied in full across resistor R.

CO-ORDINATED SCIENCES

Paper 0654/22
Multiple Choice (Extended)

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

General comments

The majority of candidates successfully selected the correct responses.

Candidates performed very well on **Questions 16**, **17** and **24**.

Physics **Question 28** was particularly well answered, but **Questions 30** and **38** were challenging for many candidates.

Comments on specific questions

Question 10

Although almost all candidates correctly identified that the plant in question was wind-pollinated, many of them believed that the diagram showed the stamen, not the stigma.

Question 12

In this question some candidates confused respiration and photosynthesis when asked to interpret a carbon cycle diagram.

Question 13

This question produced a large number of incorrect responses. Candidates must read the question carefully, and note the not in the question.

Question 16

Candidates understood well the difference between elements and compounds and their properties.

Question 17

Candidates were well able to deduce the formula of the compound cryolite from the relative numbers of atoms present.

Question 19

Stronger candidates chose the incorrect **C** rather than the correct answer, **D**. They need to be able to describe the electroplating of metals using laboratory apparatus and to know that aqueous, not molten, copper chloride is used in electroplating other metals.

Question 24

Candidates knew very well that oxygen and water are required for rusting.

Question 27

Some of the more able candidates chose the incorrect **D** rather than the correct answer, **A**. Candidates are expected to know that proteins contain the same amide linkages as nylon and that this is a condensation polymer and not an addition polymer.

Question 29

The unit for energy was widely known, but many weaker candidates confused the newton metre with the newton / metre.

Question 30

This question concerned kinetic and gravitational potential energies, and the incorrect options **B** or **D** were chosen by many. These values are obtained by dividing the initial speed by *g*, or multiplying it by *g* respectively.

Question 31

The topic here was thermal expansion and the question was generally well answered. However a slight majority of the weaker candidates thought that either heating the axle only, or heating both the axle and the wheel, would have the desired effect. Candidates need to be familiar with the idea of cooling one part so that it would contract.

Question 33

A common mistake here was for candidates to fail to divide their correctly calculated value for wavelength by 4.

Question 34

As a familiar ray diagram for students, option **B** was the most popular incorrect option, but did not show an image being formed.

Question 36

Although it was widely known that iron is used as the core of an electromagnet, several weaker candidates believed that this is because it becomes a permanent magnet.

Question 38

In this combination of resistors in series and parallel a large majority of all candidates opted for **C**, the value obtained if the 6.0 V is considered to be applied in full across resistor R.

CO-ORDINATED SCIENCES

Paper 0654/23
Multiple Choice (Extended)

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

General comments

The majority of candidates successfully selected the correct responses.

Candidates performed very well on **Questions 19** and **21**.

Questions 22, **23**, **25** and **27** proved most challenging for the candidates.

Physics **Question 37** was particularly well answered, but **Question 36** and, particularly, **Question 39** challenged many candidates.

Comments on specific questions

Questions 1 and **4** were very well answered.

Question 5

Almost equal numbers of candidates chose the correct response of transpiration, and the incorrect response of active transport. Candidates need to be clear what constitutes active transport.

Question 6

In this question concerning the villus, a substantial number of candidates believed that the lacteal absorbed amino acids; candidates need to be clearer about the different constituent of foods, and their digestion and absorption.

Question 13

In this question candidates confused respiration and photosynthesis when asked to interpret a carbon cycle diagram.

Question 15

Candidates need to be able to recognise and describe both distillation and fractional distillation as methods of separating mixtures.

Question 17

Candidates chose the incorrect **D** more often than the correct answer, **C**. They need to be able to calculate the number of moles, and hence the relative number of particles, in a mass of substance.

Question 19

Candidates understood well the changes associated with exothermic reactions.

Question 21

Candidates were well able to interpret universal indicator colour changes.

Question 22

Candidates chose the incorrect **D** more often than the correct answer, **C**. They need to be able to explain the use of zinc for sacrificial protection and to distinguish this from the use of zinc for galvanising steel.

Question 23

Candidates chose the incorrect **A** and **C** more often than the correct answer, **D**. They need to be able to explain the catalytic removal of oxides of nitrogen in car exhausts. They also need to be able to distinguish between oxidation and reduction.

Question 25

Candidates chose the incorrect **C** more often than the correct answer, **A**. They need to know the essential conditions for manufacturing sulphuric acid, including the pressure and the catalyst used.

Question 26

Candidates chose the incorrect **C** more often than the correct answer, **A**. They must read the question carefully and note that this question asked which statement was **not** correct. They appeared to choose the most obvious correct statement.

Question 27

Candidates chose the incorrect **B** more often than the correct answer, **A**. They need to know that the structure of nylon and that it contains amide linkages that are formed by condensation polymerisation.

Question 30

This question concerned kinetic and gravitational potential energies, and the incorrect option **C** was chosen by a considerable minority, with option **A** also being quite popular.

Question 31

The topic here was thermal expansion and many candidates thought that either heating the axle only, or heating both the axle and the wheel, would have the desired effect. They needed to be familiar with the idea of cooling one part so that it would contract.

Question 33

A common mistake here was for candidates to fail to divide their correctly calculated value for wavelength by 4.

Question 34

A number of candidates chose the correct option in this question on the converging lens, but a similar number thought that the image would be smaller than the object. They needed to be aware that point Y marked the end of the image.

Question 34

Slightly more candidates believed that the speed of sound is highest in gases than thought it true of solids.

Question 36

Although it was widely known that the unit for charge is the coulomb, this was thought equivalent to the ampere / second by a majority of candidates.

Question 38

Many candidates thought that the fuse should be connected across the lamp (diagram 1).

Question 39

In this combination of resistors in series and parallel the majority of all candidates opted for **C**, the value obtained if the 6.0 V is considered to be applied in full across resistor R.

CO-ORDINATED SCIENCES

Paper 0654/31
Theory (Core)

Key message

Candidates seemed to have a good understanding of what the questions were asking.

A good standard of scientific knowledge was displayed by most candidates. Some candidates should be congratulated for their clear and accurate responses.

Calculations were frequently done well with working shown.

General comments

Many candidates answered most of the questions well. Candidates generally were awarded credit on all questions. In addition to scientific knowledge, candidates need to ensure that they understand the question and express themselves clearly.

In order to gain the maximum credit available, candidates should ensure that they answer the question completely. In these cases, candidates should be reminded to read the stimulus material and each question carefully and complete all the instructions contained within the question to be able to access the maximum marks available.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Similarly, formulae consisting of a mixture of words, symbols and units should also be avoided.

Comment on specific questions

Question 1

(a) This part was well answered. Incisors were well known.

(b) The functions of both canine and molar teeth were well known. Biting food was not accepted as a function of canine teeth. A stronger response would have been cutting, tearing or ripping food.

(c) The role of teeth in the digestion process was quite well known. A common error was to suggest that teeth broke down food into smaller molecules rather than pieces. Another common error was to suggest that teeth broke down insoluble food molecules into soluble ones.

(d) The role of bacteria in the process of tooth decay was not well known, although many candidates knew that acids were involved. Strong answers explained that bacteria feed on sugar and respire producing acid which wears away teeth.

(e) Most candidates correctly suggested regular brushing of the teeth or regular visits to the dentist.

Question 2

(a) (i) Three was the correct and commonest response. Five was a common error.

(ii) Carbon dioxide and water were well known as the other two products of the reaction.

(iii) Many candidates gave an acceptable answer. Gas evolved was the popular answer. A temperature increase was rarely mentioned.

(iv) The test for chloride ions was very rarely given. Many candidates described the test for chlorine.

(b) (i) Thermal decomposition was very rarely given. Exothermic was often mentioned.

(ii) Very few candidates explained that the mass decreased because a gas was given off.

(iii) Lime, quicklime and calcium oxide were all mentioned as the identity of solid M.

(c) Some candidates knew that limestone is used to treat acidic soils.

Question 3

(a) (i) Most candidates gained the credit, although some responses seemed vague. A strong answer would have been the number of oscillations per second (or unit time).

(ii) Many candidates knew the maximum and minimum frequencies. Some placed them the wrong way round.

(iii) Most candidates interpreted the data correctly and suggested that the elephant could hear a sound with the lowest pitch.

(b) (i) Some candidates were able to correctly determine the distance. A number were out by a factor of two.

(ii) Most candidates were able to divide their answer to **(i)** by two to determine the distance between the moth and the bat.

(c) (i) Many correct disadvantages were given. The most popular answer was that the turbines would not work if there was no wind.

(ii) Solar was frequently given as an example of a renewable energy source.

Question 4

(a) The three words evaporation, mesophyll and stomata were all well known. Root hair was a common wrong response to replace mesophyll.

(b) (i) Many candidates correctly determined the mass lost as 0.55 g.

(ii) The idea that there was more mass lost because leaf **B** was kept at a higher temperature was well known. Few candidates explained that this was due to an increased rate of transpiration.

(c) Almost all candidates gained at least some credit, although few were awarded full credit. The commonest responses mentioned root hair cells and the stem.

Question 5

(a) Candidates found this part of the question challenging. The most popular answer was that all three halogens were gases.

(b) (i) 17 protons and 18 neutrons was quite well known.

(ii) The nucleus was very well known.

(c) (i) Some candidates were able to give the correct types of bonding for either sodium chloride or chlorine. Few gave both.

(ii) This question was awarded either full credit or none.

(d) The most common response was iodine. Most candidates found the question challenging.

(e) Few candidates gained credit here. Most candidates found the question challenging.

Question 6

(a) (i) Radiation was not often given as the method of thermal energy transfer between the Sun and the Earth.

(ii) Many candidates thought that ultraviolet was the main part of the electromagnetic spectrum involved in the radiation from the Sun.

(iii) Many candidates showed a good knowledge of the electromagnetic spectrum by placing their answer to **(ii)** in the correct place in the electromagnetic spectrum.

(b) (i) Few candidates explained that the air exerts a pressure on the tyre wall by air molecules colliding with the tyre wall.

(ii) Some candidates correctly explained that thermal energy causes the particles to move faster and so there are more frequent collisions with the tyre wall and therefore exerting a greater force.

(c) (i) and **(ii)** Many candidates showed a good understanding of electrical circuits and gained full credit for identifying the switches that needed to be closed.

(iii) Some candidates showed good data manipulation skills and correctly determined the resistance as 24 Ω. Other candidates inverted the formula or attempted to complete a resistances in series or resistances in parallel calculation.

(iv) This question was testing the syllabus statement *State that the combined resistance of two resistors in parallel is less than that of either resistor by itself*. Therefore candidates needed to give an answer of either 0.5 Ω or 1.0 Ω.

Question 7

(a) (i) Many candidates correctly identified the alveolus as **D** and the trachea as **A**. Fewer candidates identified the diaphragm.

(ii) Many candidates showed the direction of the air throughout the gas exchange system rather than just entering the gas exchange system. Some candidates only showed the direction once the air had entered the lungs.

(b) This question was well answered. Most candidates correctly identified the two activities that would cause the largest increase in breathing rate.

Question 8

(a) (i) Many candidates found this part of the question challenging.

(ii) Many metals were mentioned apart from the correct two - chromium and vanadium. Popular incorrect metals were cobalt and nickel, which are in the same period of the Periodic Table as iron, but not present in the alloy.

(iii) Transition metals were well known.

(b) (i) The gain in mass was correctly calculated by most candidates.

(ii) The average gain in mass per day was also correctly calculated by most candidates.

(iii) Although some candidates referred to the reaction with oxygen and water, few linked this to the idea that increase in mass was caused by the added oxygen and water.

(iv) Many candidates correctly suggested the mass of the single piece of iron after ten days by using the data given in the table.

Question 9

(a) (i) Iron and steel were commonly selected as the two magnetic metals in the list. Copper was a popular incorrect answer.

(ii) The magnetic properties of iron and steel were not well known. A strong answer was that iron is magnetised more easily than steel or that iron loses its magnetism faster than steel.

(b) (i) Lead was not often given as the material used to enclose radioactive samples and prevent the escape of ionising radiation. Uranium was often suggested.

(ii) Although the most popular and correct response was alpha, a number of candidates suggested gamma.

(iii) The effects of ionising radiation on the human body were quite well known. The strongest answers described the mutation of cells and cancer.

(c) (i) Many candidates showed good data manipulating skills and correctly determined the density as 8.96 and some candidates correctly identified the units. Other candidates inverted the formula.

(ii) Upright and laterally inverted were the two expected characteristics of the image. Many candidates unsuccessfully attempted to describe lateral inversion**.**

Question 10

(a) The anther and its function were not often given. The petal was often identified as part **D**. The sepal was quite well known as part **B** which protects the flower when in bud.

(b) Many candidates correctly identified the two methods by which pollen was transferred. A number also chose the fifth alternative, which was being dispersed in animal faeces.

(c) Candidates found this part of the question challenging. Candidates needed to take care to refer to genetically identical offspring rather than just similar offspring.

Question 11

(a) Many candidates gave distillation as their answer. Candidates needed to state fractional distillation.

(b) (i) Exothermic was well known.

(ii) Carbon dioxide and water were the only two products required. There were many incorrect answers.

(c) This question was quite well answered with many candidates gaining full credit.

(d) (i) Candidates found this part of the question challenging. The required answer was cracking. There were no popular incorrect answers.

(ii) The function of a catalyst was well known.

(iii) Few candidates answered that ethanol is produced when ethane reacts with steam. There were no popular incorrect answers.

(e) The chemical test for unsaturation was well known to some candidates.

Question 12

(a) This was well answered. Most candidates gained maximum credit.

(b) This was quite well answered. Most candidates gained at least some credit. The least-known needed candidates to identify a solid as the state of matter where particles can only vibrate but not move around.

(c) Kinetic energy and gravitational potential energy were well known as the two forms of energy gained by the truck as it accelerated up a hill.

(d) Many candidates found this challenging, but some candidates produced accurate diagrams and gained full credit. A common error was for the ray to emerge from the back of the prism.

Question 13

(a) This was well answered. Most candidates gave the correct answer as respiration. Popular wrong answers were excretion and the carbon cycle. Candidates should be reminded that breathing is not the same as respiration.

(b) Candidates found this quite challenging. A strong answer would have been to state that combustion releases carbon dioxide which is a greenhouse gas. An enhanced greenhouse effect leads to global warming. A number of candidates referred to ozone in their answers. Candidates should be aware that ozone is not mentioned in syllabus at all.

(c) Many candidates answered this well. Some candidates concentrated on the increase in oxygen rather than on the reduction in carbon dioxide.

(d) This was well answered. Many candidates gained full credit. Few candidates were awarded no credit.

CO-ORDINATED SCIENCES

Paper 0654/32
Theory (Core)

Key messages

Candidates seemed to have a fair understanding of what the questions were asking.

A good standard of scientific knowledge was displayed by some candidates. Some candidates should be congratulated for their clear and accurate responses.

Calculations were frequently done well with working shown.

General comments

Most candidates attempted all the questions. Many candidates answered most of the questions well. Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

To be awarded all the credit available candidates' responses should answer the question completely. Candidates should be reminded to read the stimulus material and each question carefully and complete all the instructions contained within the question to be able to access the maximum marks available.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Similarly, formulae consisting of a mixture of words, symbols and units should also be avoided.

Comments on specific questions

Question 1

(a) Most candidates correctly identified either the nucleus or cytoplasm. A number of candidates placed the cytoplasm inside either the vacuole or chloroplast.

(b) The differences between the structures of palisade cells and animal cell were well known.

(c) Many candidates were able to describe the diffusion of molecules as the movement from higher concentration to lower concentration. To gain maximum credit, candidates needed to able to go further and describe the random movement of the molecules.

(d) Oxygen was well known as one of the substances required for respiration. Glucose was suggested less frequently.

Question 2

(a) Some candidates were able to compare the pie charts with the composition of clean air and give clear differences. Strong answers compared the proportions of oxygen or nitrogen or other gases.

(b) (i) Strong answers to this question described the incomplete combustion of hydrocarbons. Many candidates described the formation of carbon monoxide in car engines or exhausts. These answers were considered to be too vague to be awarded credit.

(ii) Some candidates attempted to describe various vague respiratory problems. The best responses simply described carbon monoxide as toxic.

(iii) Argon was well known as the element in Group VIII and Period 3 of the Periodic Table.

(iv) Many candidates correctly described the inert nature of argon as the reason why it is not harmful to humans. A few candidates repeated the question and stated that argon was not harmful to humans.

(c) (i) The nitrogen molecule or the oxygen molecule was usually correctly identified as the molecule of an element. Few candidates were able to explain their response. A strong explanation stated that an oxygen molecule only contained one type of atom.

Carbon dioxide was a common incorrect answer.

(ii) The molecule of water was identified by almost all the candidates and most were able to explain that a water molecule contained two hydrogen atoms and one oxygen atom.

(iii) Candidates need to ensure that they know the test for water. Very few candidates suggested either cobalt chloride or anhydrous copper sulfate. There were even fewer responses giving the correct colour change.

Question 3

(a) The use of X-rays was well known.

(b) Few candidates were able to link X-rays or gamma rays with the effects of ionising radiation on the human body. Many vague answers describing harming the unborn baby were given, these were not awarded credit. A strong answer referred to ionising radiation and gave one effect of ionising radiation on body cells.

(c) (i) Most candidates were able to gain the credit, although some responses seemed vague. A strong answer would have been the number of oscillations per second (or unit time).

(ii) Some candidates were able to use their knowledge of the human audible frequency range and explain that the frequency was higher than 20 000 Hz because 20 000 Hz was the upper limit of the audible frequency range.

Question 4

(a) (i) 65 beats per minute was the most popular and the correct answer.

(ii) Candidates needed to look at the graph carefully and to note that the race began at 5 minutes. Many determined the time at which the athlete's pulse rate reached a maximum as 15 minutes rather than 10 minutes.

(iii) Many candidates determined, incorrectly, that the race finished after 55 minutes. The correct answer was 35 minutes. This was indicated on the graph as the time when the pulse rate started to drop.

(b) The heart muscle contracting / pumping / beating faster was well known**.**

(c) Candidates need to ensure that they know that the aorta is the blood vessel that transports blood from the heart to the body. There was no common wrong answer.

(d) Red blood cells were well known as the component of the blood responsible for the transport of oxygen. Platelets was a common wrong answer.

Question 5

(a) (i) Cu and K were the correct answers and most candidates correctly identified them. Candidates need to ensure that they are clear about the difference between proton number and mass number.

(ii) Many candidates showed a good understanding of atomic structure by stating that copper contained the greater number of electrons because copper had more protons and therefore more electrons.

(iii) The definition of mass number was well known.

(b) Many candidates gained at least partial credit. Candidates were able to express their ideas clearly and suggest ideas such as potassium reacting with water and potassium being a soft / weak metal.

(c) (i) Many candidates found this question challenging. The reactant and the product were all given in the question.

(ii) Candidates need to ensure that they are familiar with thermal decomposition. Exothermic was frequently suggested.

(iii) The limewater test for carbon dioxide was well known.

(iv) Candidates found this challenging. This part of the question asked about compounds of transition elements. Answers suggesting that the compounds were hard or had a high density refer to transition elements so were not accepted. Strong answers included a reference to the colour of transition element compounds or the use of transition element compounds as catalysts.

Question 6

(a) Few candidates gained full credit on this question. A strong answer would have shown two lamps in parallel with a battery and a fuse and switch included to protect / control both lamps. Candidates need to know the symbol for a fuse. A number of candidates drew a series circuit.

(b) Good data manipulation skills were shown by many candidates who correctly calculated the resistance. Candidates need to know that the ohm is the unit of resistance.

(c) Kinetic energy and gravitational potential energy were well known as the two forms of energy gained by the truck as it accelerated up a hill. Force was a commonly suggested incorrect answer.

(d) Upright and laterally inverted were the two expected characteristics of the image. Many candidates unsuccessfully attempted to describe lateral inversion.

(e) (i) Many candidates were able to explain that the negative charges on the paint droplets would be attracted to the positive charges on the bodywork.

(ii) Few candidates explained that the negative charges on the paint droplets would repel each other ensuring that the paint droplets spread evenly over the bodywork.

Question 7

(a) (i) Homozygous and dominant were the two most popular and correct terms used to describe the genotype **DD.** Polydactyly, **d, D**, and **DD** were all incorrectly suggested.

(ii) Many candidates were able to state that the genotype of a person that does not have polydactyly was **dd.**

(b) The genetic diagram was successfully completed by most candidates. There was no common error.

(c) Many incorrect answers suggested that the identical twins had different genes. Only a few candidates suggested that the differences were caused by the environment. A popular and acceptable example was hair length.

(d) (i) The joining of nuclei was not well known but many candidates correctly suggested sperm and eggs as the two gametes.

(ii) Many candidates correctly identified the chromosome pairs of a male and female human as XY and XX respectively. There were many incorrect answers, particularly *23 and 23*. Candidates must read the question carefully.

Question 8

(a) (i) Many sensible uses for limestone were suggested. Strong answers included making lime, neutralising acidic soil and used in the blast furnace.

(ii) Candidates need to be able to describe the atom as containing equal numbers of protons and electrons or the ion as containing more protons than electrons.

(b) (i) Calcium chloride was not well known as the salt produced. Calcium oxide was often suggested.

(ii) Few candidates suggested that carbon dioxide reacted with water or that the carbon dioxide turned the water acidic.

(iii) Many candidates gave at least one correct response here. To gain credit they needed to state that the change was an increase. For example, increase the acid temperature rather than change the acid temperature.

Question 9

(a) (i) Many candidates correctly determined the time as 600 seconds. Some candidates chose 300, 400 or 500 seconds.

(ii) Many candidates calculated the average speed of the train using their answer to **(i)**.

(b) Candidates need to be aware of different types of energy; chemical energy was not well known. A number of candidates suggested potential energy. This was not accepted but chemical potential energy was accepted.

(c) (i) Coal was frequently given as a correct answer.

(ii) Solar was frequently given as an example of a renewable energy source.

(d) (i) The driving force was commonly identified as **Q**.

(ii) The weight of the train was commonly identified as **R**.

(iii) Many candidates did not suggest that force **Q** would be greater than force **S** or that force **Q** and force **S** would act in opposite directions.

Question 10

(a) More candidates were able to identify the hair than the sweat gland.

(b) (i) Many candidates referred to sweating but few referred to either vasodilation or the skin going red.

(ii) Few candidates defined homeostasis as the maintenance of constant internal environment.

(c) Candidates found this challenging. A strong answer would have referred to the central nervous system, described the pathway from sensory neurone to relay neurone to motor neurone and referred to the effector or muscle involved.

Question 11

(a) (i) Candidates need to know the constituents of natural gas; methane was not well known as the main constituent. There was no common incorrect response.

(ii) Candidates need to know the products formed when natural gas is burned completely; water was not well known as the other product formed.

(iii) Exothermic was well known.

(b) (i) Many candidates were able to interpret the data in the table and conclude that the larger the molecules the higher the boiling point. A few candidates referred to temperature rather than boiling point.

(ii) This was well answered by many candidates, who suggested that it was molecules **A**, **B** and **C** because their boiling points were below 20 °C.

(c) Most candidates gained some but few gained full credit. The structure of ethane was the better known.

(d) (i) The colour of bromine solution was well known.

(ii) Candidates found this challenging. The strongest answer would have been that the hydrocarbon molecules were unsaturated.

Question 12

(a) (i) Conduction was well known as the method of thermal energy transfer through the base of the saucepan.

(ii) Some candidates only drew one or two arrows and were unable to show how the warmed water circulated around the saucepan. A strong explanation needed four to six arrows.

(iii) Convection was well known.

(b) (i) Many candidates were aware of problems caused by thermal expansion of metals. Some of the responses made were very vague. For example some candidates simply referred to railway tracks. Stronger responses explained the problem and suggested that railway tracks have gaps left between them to allow for expansion in hot weather.

(ii) Few candidates suggested any reasonable response. A strong answer would have referred to a bimetallic strip or thermostat or mercury thermometer or shrink fitting.

(c) Most candidates gained some credit here but few gained full credit.

(d) Many candidates found it challenging to define boiling. A strong answer was the temperature at which a liquid changes into a gas.

(e) Candidates need to ensure that they know about the magnetic properties of iron and steel. A strong answer was that iron is magnetised easier than steel or that iron loses its magnetism faster than steel.

(f) (i) Microwaves were placed correctly in the electromagnetic spectrum by most candidates.

(ii) Radio waves were well known as the part of the electromagnetic spectrum that has the lowest frequency.

Question 13

(a) (i) Many candidates gained partial here but few gained full credit. Chemical digestion was quite well known but an example of mechanical digestion was less well known. Rather than describe food

being chewed by or ground up by teeth many candidates gave vague general descriptions of digestion.

(ii) Very few candidates were able to describe the movement of the digested food molecules through the wall of the small intestine and into the blood.

(b) (i) This was well answered with most candidates gaining full credit. Almost all candidates were awarded some credit.

(ii) Few candidates were able to identify carbon, hydrogen and oxygen as the elements present in fats. Calcium and magnesium were frequently suggested.

(c) Few candidates were able to define a balanced diet. A strong answer would be a diet that contains all required nutrients in sufficient proportions.

CO-ORDINATED SCIENCES

Paper 0654/33
Theory (Core)

Key message

Candidates seemed to have a good understanding of what the questions were asking.

A good standard of scientific knowledge was displayed by most candidates. Many candidates should be congratulated for their clear and accurate responses to some questions.

Calculations were frequently done well with working shown.

General comments

Most candidates attempted all the questions. Some candidates answered most of the questions well. Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

Candidates should ensure that they answer the question fully in order to access all the credit available. In these cases, candidates should be reminded to read each question carefully and complete all the instructions contained within the question to be able to access the maximum credit available.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Similarly, formulae consisting of a mixture of words, symbols and units should also be avoided.

Comments on specific questions

Question 1

(a) (i) The willow tree and the spruce tree were very well known as the producers in the food web.

(ii) The hare and the caterpillar were very well known as the herbivores in the food web.

(b) (i) Many candidates were able to explain that the hare population would increase due to less predation by foxes.

(ii) Many candidates were able to explain that the lynx population would increase because there was less competition from foxes and that therefore there would be increased availability of food.

(c) Candidates found this question challenging. Some very strong answers explained that fewer trees meant less food and shelter and that this would disrupt the food web.

Question 2

(a) (i) Most candidates only knew one of the three physical states. Very few knew all three.

(ii) Few candidates were able to explain that if the atomic number of chlorine was 17 then chlorine atoms contained 17 protons.

(iii) Many candidates were able to determine that the number of electrons in an atom of bromine was 35 and explain that the number of electrons in an atom was equal to the number of protons or atomic number.

(b) (i) Some candidates correctly explained that the ions have opposite charges and that opposite charges attract each other. Other candidates referred to gaining and losing electrons. This did not answer the question.

(ii) Many candidates were able to answer this question by explaining that an electron is lost from the sodium ion and transferred to the chlorine atom.

(c) (i) Filtration was well known.

(ii) Candidates found this challenging. A strong answer would have been to heat the solution and leave to evaporate. Many candidates incorrectly suggested cooling the solution or freezing the solution.

(d) The test for chloride anions was not well known. Candidates must ensure that they know the tests for specific anions.

Question 3

(a) Many candidates gained full credit here and almost all candidates gained at least partial credit.

(b) There were some accurate circuit diagrams drawn by some candidates. Many candidates did not know the correct symbol for an electrical cell. Candidates need to know the symbols for specific electrical components.

(c) Good data manipulation skills were shown by many candidates who correctly calculated the resistance as 5 Ω. Some candidates inverted the formula.

(d) (i) Most candidates correctly identified the effect as reflection. Refraction was a popular incorrect answer.

(ii) Many candidates correctly labelled the angle of incidence. Some candidates attempted to label the incident ray.

(e) (i) Most candidates were able to state one other renewable energy source. Energy from the wind was the most popular.

(ii) Coal was the only correct non-renewable energy source suggested. A number of candidates incorrectly suggested petrol or batteries.

Question 4

(a) The definition of transpiration was not well known; candidates should ensure that they know it. Respiration was a popular incorrect response.

(b) (i) Most candidates correctly determined the difference in mass as 0.10 g. Some candidates omitted the unit however.

(ii) Many candidates correctly explained the difference in mass. Some candidates vaguely suggested the humidity. A strong answer would have included the idea of increased humidity.

(c) Candidates found this challenging. Candidates needed to refer to root hair cells rather than just roots. The idea of diffusion was rarely mentioned.

(d) (i) Water and mineral ions were well known as the two substances transported by xylem in plants. Oxygen and carbon dioxide were sometimes chosen.

(ii) Support was not well known as another function of xylem. Protection of the plant was sometimes incorrectly suggested.

Question 5

(a) (i) Candidates found this part challenging. Some candidates reversed the order. Some candidates chose different metals.

(ii) Copper and iron were quite well known as transition elements. A number of candidates only selected one metal.

(b) (i) Few candidates identified the gas released as hydrogen. Carbon dioxide and various calcium compounds were frequently suggested.

(ii) Some candidates chose a pH below 7, some candidates chose a pH of 7 and some candidates correctly chose a pH above 7. Few candidates gave a satisfactory explanation.

(iii) Most candidates knew the colours of full range indicator in an acidic solution and in an alkaline solution. A few candidates reversed the colours.

(iv) Many candidates were able to describe what was meant by the term exothermic. A strong answer would have described a reaction where the temperature increased or thermal energy was given out.

(c) (i) Most candidates correctly identified oxygen as the substance that must be present for iron to rust.

(ii) Many candidates answered this question well. The idea that a barrier needed to be present to prevent contact between iron and air and water was often clearly expressed. Many different barriers were suggested.

Question 6

(a) (i) Many candidates were able to state what was meant by the term audible frequency range.

(ii) Many candidates correctly stated the lowest and highest frequencies. Where candidates only gave one correct frequency it was usually the highest frequency that was correct.

(iii) This was well answered. Most candidates knew the connection between pitch and frequency.

(iv) This was well answered. Most candidates were able to use the data in the table to determine the correct response.

(b) Good data manipulation skills were shown by many candidates who correctly calculated the speed.

(c) Good data manipulation skills were shown by many candidates who correctly calculated the density. Some candidates gave incorrect units such as kg or J.

Question 7

(a) Many candidates identified one or other ovary as the place where an egg is released.

(b) Many candidates gained full credit. Some candidates need to ensure that they know the functions of the cervix and uterus.

(c) A few candidates gained full credit showing a good understanding of the sequence of events. Candidates need to ensure that they can clearly describe the menstrual cycle.

(d) Some candidates described what happened before the formation of a zygote. A strong answer described the passage of the zygote down the oviduct, into the uterus and cell division producing a ball of cells that implanted into the uterus wall.

Question 8

(a) (i) Oxygen was well known as the element that combines with sulfur when it burns.

(ii) Candidates should ensure that they know that sulfur dioxide is the gas formed when sulfur burns. A number of candidates suggested sulfur oxide, which was not accepted. Popular incorrect answers were carbon monoxide and carbon dioxide.

(iii) Some candidates correctly suggested that sulfur dioxide was toxic or caused breathing or lung problems.

(b) (i) Candidates found this challenging. The question asked about compounds of transition elements. Answers suggesting that the compounds were hard or had a high density were not accepted since they were about properties of transition elements. Strong answers included a reference to the colour of transition element compounds or the use of transition element compounds as catalysts.

(ii) Some candidates correctly predicted that the bonding in hydrogen sulfide would be covalent. A number of candidates suggested ionic bonding. Few candidates were able to give a clear explanation. A strong explanation would have described the bonding as being between two non-metals.

(iii) Candidates found this very challenging. There were many possible correct answers including the idea of separating iron from sulfur by using a magnet for a mixture but not for a compound.

Question 9

(a) Some candidates gave some well thought out properties such as aluminium was unreactive or did not corrode or that it had a low density. A number of candidates suggested that aluminium was suitable because it was either a good conductor or good insulator and would therefore keep the food hot.

(b) (i) Many candidates were able to explain that the air molecules would move faster as the air warmed up.

(ii) Some candidates correctly explained that thermal energy caused the particles to move faster and so there were more frequent collisions with the tyre wall that exerted a greater force.

(c) Candidates answered this question well, choosing from the list of words and phrases.

(d) (i) Radiation was not well known as the method of thermal energy transfer between the Sun and the Earth.

(ii) Many candidates thought that ultraviolet was the main part of the electromagnetic spectrum involved in radiation from the Sun.

(iii) Many candidates showed a good knowledge of the electromagnetic spectrum by placing their answer to **(ii)** in the correct place in the electromagnetic spectrum.

(iv) Candidates must ensure that they know the properties of radioactive emissions. Differences between beta particles and gamma rays were not well known. Simple differences such as beta being more ionising or beta being less penetrating were missing from most answers.

Question 10

(a) Most candidates were able to complete the sentence by choosing the correct words genetic and generation.

(b) (i) **aa** was quite well known as the genotype.

(ii) Heterozygous was not well known as the term used to describe the genotype **Aa**.

(c) Candidates found expressing their answers challenging. Answers which gained credit usually included ideas about recessive alleles

Question 11

(a) (i) A few candidates drew careful diagrams of the structure of ethene. A number of candidates drew the structure for methane. A common error was to omit the double bond behind the two carbon atoms and draw a single carbon-carbon bond instead.

(ii) Cracking was not well known as the process used to produce alkenes from alkanes. Fractional distillation was a popular incorrect answer.

(b) (i) The colour change observed when testing for the presence of unsaturated hydrocarbons was not well known. Many candidates incorrectly suggested bubbles as they were shown on the diagram.

(ii) Very few candidates suggested one reason. A strong answer would have referred to ideas like getting the same result with other alkenes or getting the same result if the ethane was impure.

(c) (i) There were a number of possible correct answers given by candidates. Strong answers described alkanes as containing carbon and hydrogen only or not containing oxygen or not having an –OH group.

(ii) Many candidates were able to state a use for ethanol, often as a solvent or fuel.

(d) Some candidates understood this question. Candidates needed to explain that the reading would decrease because carbon dioxide and water vapour were released. Many candidates gained credit relating to the reading decrease. Fewer could explain the reason for the decrease.

Question 12

(a) (i) Most candidates needed a better understanding of the arrangement of molecules in a solid and in a liquid. Some candidates referred to the properties of solids and liquids rather than what the molecules were doing. A strong answer for a solid would have referred to a close packed regular arrangement. A strong answer for a liquid would have referred to molecules being close together or most touching in an irregular arrangement.

(ii) Changes of state were well known. Most candidates gained at least partial credit. There were no common errors.

(b) Convection was quite well known. Conduction and condensation were common incorrect answers.

(c) This was well answered. Most candidates showed good data manipulation skills and correctly determined the combined resistance as 9 000 Ω.

(d) (i) and (ii) This question was testing the syllabus statement – State that the combined resistance of two resistors in parallel is less than that of either resistor by itself. Therefore candidates needed to give an answer of 2 000 Ω.

Question 13

(a) (i) Many candidates were able to extract information from the diagram and answer the question well.

(ii) Valves were not well known as the structure usually found in veins but not shown on the diagram. Red blood cells were often suggested.

(b) Many candidates knew that red blood cells were involved. Fewer referred to role of haemoglobin.

(c) The pulmonary vein was well known as one of veins that carry blood to the heart. The vena cava was less well known. Candidates often suggested the aorta.

CO-ORDINATED SCIENCES

Paper 0654/41
Theory (Extended)

Key messages

Candidates need to understand the terms used in the instructions, particularly: *describe, describe how* and *explain.*

Describe requires the candidate to state in words the main points of the topic, where *state* implies a concise answer with little or no supporting argument.

Describe how requires a description of the mechanism of a phenomenon.

Explain may imply reasoning or some reference to theory.

Explain your answer may require the candidate to state why they have given a particular response in terms of their own knowledge or experience.

This message is based on the G*lossary of terms used in science papers* provided in the syllabus and which could form the basis of candidates' training in examination technique.

General comments

This key message was illustrated by responses to **Question 4(a)(i)** (*Describe the* results) **and (ii)** (*Explain the results*).

Good responses to **4(a)(i) described** the change in the number of white blood cells as a rapid decrease and increase in the first half year, followed by a decrease.

Good responses to **4(a)(ii) explained** the decrease as being due to the HIV killing white blood cells.

In another context, good responses to **Question 2(b) explained** the results as the mass of limestone decreasing because limestone is decomposed by heating, and the mass of sand did not change because sand does not decompose, rather than just **describing** the changes in mass as a decrease and no change.

Comments on specific questions

Question 1

(a) (i) The majority of candidates correctly named decomposers or bacteria as the organisms responsible for transfer of carbon from dead organisms to carbon dioxide.

(ii) Some explained that respiration causes loss of carbon taken in by animals and not passed on to dead organisms. A few candidates knew the role of excretion.

(iii) Many knew that process **D** is nutrition. Respiration was a common incorrect answer.

(b) (i) Most knew that process **A** is combustion.

(ii) Most candidates stated that the combustion of fossil fuels is increasing the temperature of the Earth, many using the phrase *global warming*. Some correctly explained this in terms of the greenhouse effect. A very few described the mechanism of the greenhouse effect in terms of

absorption of radiation emitted by the Earth followed by re-radiation in all directions. Many demonstrated the misconception that the ozone layer is involved.

(c) Reforestation was usually the suggestion for the way to remove carbon dioxide from the atmosphere, sometimes explained by increased photosynthesis. The suggestion that more plants should be grown was not accepted as the use of land gained from forests for crops would not necessarily be beneficial.

Question 2

(a) (i) Many of the observations made when acid is added to limestone included effervescence or reduction in the size of the piece of rock. Results of the reaction such as change in temperature were not accepted as they could not be seen.

(ii) Carbon dioxide and water were often identified as products of the reaction and calcium chloride was written by some.

(b) Some candidates explained the loss of mass of limestone when heated in terms of the release of carbon dioxide by thermal decomposition. Fewer stated that sand does not decompose. A common misconception was that a change in state is accompanied by loss of mass.

(c) (i) *Giant covalent* or *macromolecule* was correctly stated by some as the term used to describe the structure of diamond. *Lattice* structure was also accepted although this term is more often applied to ionic structures.

(ii) The formula SiO_2 was sometimes correctly used to state the ratio of silicon to carbon atoms. Candidates were more likely to describe silicon(IV) oxide as consisting of SiO_2 molecules in spite of the information given in **Fig. 2.2**.

(iii) The high melting point of silicon(IV) oxide was sometimes explained in terms of the strength of bonds and less often by the number of bonds. Some candidates recognised that thermal energy is needed to break bonds.

(iv) Many candidates knew that diamonds are used in cutting tools. Decorative uses did not add much to the information in the question.

Question 3

(a) (i) Most candidates drew an accurate diagram of a circuit employing four cells to power independently switched lamps in parallel. Switches were sometimes put in the wrong place. It is important that candidates check they have drawn a working circuit; without connections drawn across the cells or gaps included in the circuit.

(ii) This Ohm's law calculation was done well by many.

(iii) Those who knew the relationship between charge and current usually substituted current and time correctly. Some candidates realised they had to convert the units of time.

(b) Most candidates drew an accurate ray diagram. Fewer identified the angle of incidence. Many used the laws of reflection to state the angle of reflection.

Question 4

(a) (i) A few candidates described the results in sufficient detail to gain full credit. They described the changes in white blood cell count in the first six months as well the subsequent decline. Some credit was given to those who simply described the overall decrease.

(ii) A few candidates **explained** the results as the virus destroying white blood cells. Most responses **described** the decrease in white blood count again.

(b) The best descriptions of how white blood cells defend against disease included the release of antibodies and the destruction of pathogens. They included correct use of the term *phagocytosis*.

Candidates were not given credit for *destroying disease*. Credit was available for additional valid points.

(c) Many candidates knew the functions of platelets and red blood cells.

Question 5

(a) Those who knew the physical states of the Group VII elements could describe the trend. Several candidates confused trend in physical state and the trend in reactivity.

(b) Group number was used by most to state the number of outer shell electrons.

(c) (i) Many candidates gained credit for at least part of an explanation for the charge on the iodide ion. The best responses separated the two parts of the question by first explaining the neutrality of the iodine atom and then explaining the charge on the iodide ion.

(ii) A very few candidates completed the balanced ionic equation.

(d) (i) Hydrogen was often correctly identified as the product of the electrolysis. Potassium was sometimes suggested.

(ii) Successful explanations of the formation of iodine by electrolysis included ideas about iodine atoms, iodide ions and electron transfer as directed by the question. Useful points in the explanation included ions being attracted to the anode, ions receiving one electron, ions becoming atoms, and atoms forming iodine molecules. Many answers were confusing when reference was made to *iodine ions*.

Question 6

(a) (i) Those who knew the human range of audible frequencies could explain why sound produced by the bat is audible to humans.

(ii) Candidates who could rearrange the relationship between wave speed, frequency and wavelength usually evaluated the frequency correctly. Some who could not recall standard symbols may have been more successful if they had used words in their formula.

(iii) The difference in pressure or particle spacing was usually used in the description of the difference between a compression and a rarefaction. There seemed to be some confusion between compression and frequency variation.

(iv) Some candidates could define wavelength in terms of compressions.

(b) (i) The speed of sound was sometimes quoted correctly, with mistakes in the power of ten being common.

(ii) Ultraviolet was often placed in the correct position in the electromagnetic spectrum, with placement at the longer wavelength end of visible light being a common mistake.

(iii) Many candidates knew that γ-rays are at the high frequency end of the electromagnetic spectrum.

(c) (i) The correct value for the time taken for the bat to fly was usually found.

(ii) The kinetic energy formula was well known. Many candidates were able to substitute into the formula correctly. Some realised the need to convert the units of mass into kilograms.

Question 7

(a) (i) The lack of nitrate ions was sometimes suggested as the deficiency causing stunted growth. Nitrogen and magnesium were not acceptable suggestions.

(ii) Stronger candidates explained that nitrate ions were needed for protein synthesis. The inability to make chlorophyll was often incorrectly suggested.

(b) There were a few very good answers to this structured question about the changes occurring during eutrophication. They included a description **and** an explanation of each change, as follows:

(i) The plants on the surface of the water grow more
because of increased nitrate content of the water.

(ii) The plants under the surface of the water die
because sunlight is blocked so they cannot photosynthesise.

(iii) The bacteria in the water reproduce
because they decompose dead plants.

(iv) The oxygen content of the water decreases
because of respiration by bacteria.

Some unsuccessfully attempted explanations based on a direct relationship between lack of photosynthesis and reduced oxygen.

(c) Many candidates knew the role of the phloem in the transport of sugars, or used the term *translocation* correctly. The fact that glucose is converted to sucrose was not well known.

Question 8

(a) Many candidates knew the metals are transition metals. Some read the question as requiring a list of the metals in the fourth period.

(b) (i) The Haber process was named correctly by many.

(ii) Both elements that combine to make ammonia were stated by a few candidates.

(c) (i) A pH above 7 was often correctly suggested for the mixture resulting from the reaction between potassium oxide and water. Some gained credit by simply explaining that an alkali was formed. Others seemed to be under the impression that elemental potassium, an alkali metal, had been added to the water.

(ii) Those candidates who realised that iron oxide is insoluble in water quoted a pH of 7.

(d) (i) Some candidates suggested sulfur dioxide or nitrogen dioxide as a cause of acid rain.

(ii) When a correct reason for the low rate of reaction of acid with limestone was provided, the explanation was often given in terms of frequency of particle collision, or in the case of the effect of low temperature, the energy of collision. Credit was not awarded for responses explaining in terms of **number** of collisions.

Question 9

(a) (i) Those who knew the correct symbol for an α-particle could usually work out the symbol for the uranium nuclide.

(ii) The best explanations involved lower penetration through the skin as being the factor responsible for the greater danger of swallowing the α-radiation source.

(b) The best descriptions of the difference between nuclear fission and nuclear fusion included definitions of the two processes. This topic was not well known.

(c) (i)(ii) A very few candidates explained that each side of the coil of a generator cuts the field to induce a voltage and does so in different directions relative to the field as it turns to induce an alternating voltage.

(iii) More candidates drew a sinusoidal waveform with a constant amplitude and period to represent the generator output.

Question 10

(a) (i)(ii) Some candidates knew that gaseous exchange occurs between the alveolus and the blood and drew arrows for the diffusion of oxygen and carbon dioxide in the right directions. Diagrams did not always make it clear that oxygen is diffused into red blood cells.

(iii) At least one **visible** feature responsible for the efficiency of the alveolus as a gas exchange surface was usually described.

(b) The term *respiration* was usually defined correctly. Most errors occurred in identifying the material that is broken down.

Question 11

(a) Most candidates could name a petroleum fraction. Complete answers stated use as a fuel rather than just naming a device in which it is used.

(b) Correct names were often given for all the alkanes.

(c) (i) Some candidates knew that alkenes are produced by cracking alkanes.

(ii) Some complete calculations were seen. Steps 1 and 3 of the calculation were often carried out correctly. The chemical equation was seldom used to find the number of moles of ethene obtained.

(d) The diagram showing covalent bonding in an ethene molecule was often drawn correctly, candidates ensuring that the hydrogen atoms had a share in two electrons each, and the carbon atoms had a share in eight electrons each.

Question 12

(a) The description of the differences between a solid and a liquid was completed correctly by most candidates.

(b) A few good answers explained that energy is required to overcome forces of attraction or to break bonds between molecules when ice melts. They included the term *latent heat of fusion* in the context of the energy required to melt the ice.

(c) Several full descriptions of how all the air in the refrigerator is cooled included an account of cool air falling **and** warm air rising, and named the flow of air as a convection current.

(d) Many candidates knew the formula for energy transfer and most of those succeeded in the calculation.

Question 13

(a) The comparison of nervous control with hormonal control in terms of speed of transmission and duration of response was done quite well. Fewer candidates described nervous control as carrying information as electrical impulses **and** as carrying it via neurones or nerves.

(b) (i) Most candidates knew that the heart is the target organ affected by adrenaline.

(ii) Some could describe another effect of adrenaline.

(iii) Many identified the liver as the organ that destroys adrenaline. Several selected the kidney.

(c) Many candidates named insulin as a hormone released by the pancreas. Some of those also correctly identified glucagon.

CO-ORDINATED SCIENCES

Paper 0654/42
Theory (Extended)

Key messages

A high standard of scientific knowledge and understanding was displayed by many of the candidates. Many candidates should be congratulated for their articulate and accurate responses.

- Calculations were generally done well with working shown. Candidates are expected to give correct units with their answers and round their answers up or down to an appropriate number of significant figures. These skills were required in **Questions 6(a)(ii) and 12(c)(ii)**.
- It would be beneficial for candidates to practise expressing values in standard form as this proved problematic for some.
- Candidates should be encouraged to read the question carefully and to complete all the instructions contained within the question. Questions such as **5(c)(ii)** and **9(c)(ii)** required candidates to refer to specific scientific terms in their responses.

General comments

Questions where candidates are required to annotate diagrams are often omitted. In these cases, candidates should be reminded to read the stimulus material in each question carefully and complete all the instructions contained within the question to be able to access the maximum credit available.

Candidates generally showed good use of English, expressing their ideas in continuous prose. Correct scientific terminology as stated in the syllabus should always be used. Learning the definitions specified in the syllabus earns credit directly as well as being an aid to language used in explanations.

There were several instances were candidates rewrote the stem of the question instead of providing new information in their answers. It would be beneficial for some candidates to practise highlighting key information in the stem particularly the command words to identify what is expected from them in their responses.

Comments on specific questions

Question 1

(a) Most candidates could identify and label the xylem and phloem tissues. A number of candidates muddled the xylem with the phloem. Occasionally other incorrect parts of the root section were labelled. It was pleasing to see the majority of candidates labelled the tissues with neat ruled lines.

(b) Candidates need to ensure that they understand the mechanism of water movement through the xylem. A number of candidates gave detailed responses on the passage of water into the plant root. Whilst correct this could not be awarded credit because it is not what the question asked for. Some candidates recalled that transpiration was involved; they also needed to explain that this caused a reduction in pressure drawing a column of water up the xylem. Some candidates mentioned cohesion; they need to ensure that they are clear what this term means.

(c) (i) The majority of candidates answered this question well with many references to root hair cells increasing the surface area.

(ii) The vast majority of candidates gained credit for correct references to absorption of mineral ions or anchorage in the soil. Candidates should be reminded to refer to mineral ions rather than nutrients.

Question 2

(a) Most candidates gave the correct percentage. Very few candidates stated percentages of other components of air in error.

(b) Some candidates stated a higher temperature than the answer required and tried to explain this in terms of fractional distillation. Most candidates recognised that a suitable temperature would be between the boiling points of nitrogen and oxygen. Some candidates gave a correct temperature but simply restated the information in the stem rather than provide an explanation as to why they had selected this temperature. A few candidates gave the correct numerical value but omitted the negative symbol, thus negating the credit.

(c) (i) The majority of candidates gave the correct order of the steps involved in producing ammonium nitrate.

(ii) The majority of candidates gave the correct gas of hydrogen.

(d) (i) Some candidates found it challenging to depict the bonding in a molecule of nitrogen. Some candidates did not show a triple bond and instead showed the nitrogen atoms sharing just one pair of electrons. A small number of candidates showed the correct sharing of three pairs of electrons but omitted the lone pairs.

(ii) There were many references to intermolecular forces rather than bonds between the atoms. Candidates need to be clear about whether energy is required for making or breaking bonds. They should be reminded that energy is required to **break** bonds.

(iii) Candidates that recognised that the pH would decrease, generally also gained all the credit available, with many references to acid rain. Some candidates tried to quote pH values. These were not accepted unless a decrease was shown.

Question 3

(a) (i) Most candidates added a correct line to the graph. A common error was to start the line at the origin.

(ii) The vast majority of candidates were able to show how acceleration was calculated.

(iii) Most candidates recalled and used the correct formulae. A few candidates used weight rather than mass to calculate the force; so could not be awarded credit.

(iv) Most candidates recalled and used the correct formulae. A few candidates did not square the velocity; so could not be awarded credit. It was pleasing to see that most candidates stated the formulae they used. This enabled some candidates to gain credit even if they had made an error in their calculations.

(b) Care should be taken when identifying parts of a wave. A small number of candidates were inaccurate in their labelling and drew arrows that were too short to show the amplitude. A few candidates incorrectly labelled the wavelength or the total displacement of the wave.

(c) (i) The majority of candidates could correctly show the direction of movement of the particles in a sound wave.

(ii) The majority of candidates could correctly show the direction of movement of the particles in a water wave. However, this was fewer than in part **(i)**.

(iii) There were some imprecise answers seen with many candidates referring to waves instead of compressions. Most candidates simply referred to the number of compressions rather than the number of compressions **produced**.

Question 4

(a) (i) Many candidates stated that the high temperature would kill any harmful bacteria. It should be noted that high temperature will not remove the bacteria.

(ii) Some excellent answers were seen with correct references to anaerobic respiration producing lactic acid. It was also clear that a number of candidates did not appear to know about the use of microorganisms in the production of yoghurt.

(iii) Many candidates recognised that enzymes were involved in this reaction. Candidates should be reminded that enzyme activity is low at low temperatures due to less kinetic energy and lower rate of collisions between the enzyme and the substrate.

(b) (i) This was well answered with the vast majority of candidates able to link the nutrient with a major source.

(ii) The correct answer of scurvy was commonly seen. There were also a number of candidates that gave rickets as the disease.

Question 5

(a) (i) A number of candidates gave general properties of metals rather than properties of transition metal compounds. Those candidates that recognised that this was a transition metal compound commonly gave the correct answer.

(ii) The majority of candidates named the correct gas produced as hydrogen.

(iii) Many correct answers were seen. A few candidates gave the incorrect colour and some gave the correct colour but did not include that a precipitate would be formed.

(b) (i) Many correct answers were seen. Occasionally candidates referred to the reactivity of copper oxide rather than copper.

(ii) Candidates that wrote the correct formulae could generally balance the equation. A common error was to try and balance the equation by giving the copper product as Cu_2 rather than 2 Cu.

(c) (i) The correct answer of copper sulfate was commonly seen. Other soluble copper salts were also acceptable.

(ii) There were numerous responses that referred to copper rather than copper **ions** being attracted to the cathode. Several candidates identified the copper ions as gaining electrons. Candidates should be encouraged to read the question carefully. There were candidates that did not include reference to electrons or ions as instructed by the question.

Question 6

(a) (i) Many candidates could correctly place different parts of the electromagnetic spectrum.

(ii) Many candidates identified the correct formula to use. There were some inaccuracies with expressing the answer to three significant figures. It would be beneficial for candidates to practise these skills. Some candidates found it challenging to calculate the answers due to the magnitude of the values.

(b) (i) There were a variety of types of mirror drawn. In this case the mirror should have been drawn as a single straight line at the point of reflection. Most candidates that drew a mirror at the point of reflection drew it at the correct angle.

(ii) Identifying the angle of incidence proved challenging, as candidates had to draw the normal on the diagram.

(iii) Many candidates gave the correct figure and explanation with many quoting that *the angle of incidence is equal to the angle of reflection*.

Question 7

(a) (i) Many candidates recognised that glucose was used as the body requires more energy during exercise. Responses such as *glucose produces energy* were not awarded credit. A number of candidates correctly linked this idea to respiration.

(ii) There were some excellent responses seen. Candidates that realised this was due to the action of glucagon generally gave detailed and accurate responses. Some candidates tried unsuccessfully to link this to less exercise being done.

(b) (i) There were some good responses clearly linking the control of blood glucose concentration to the idea of negative feedback. The best responses highlighted the idea of blood glucose concentration having a set point or normal level and any deviation from this caused a response to return the concentration to the set point.

(ii) Many candidates gave the correct response of temperature control. Thermoregulation was also acceptable.

Question 8

(a) Some good responses were seen. Occasionally candidates were too vague in their responses, referring simply to neutralisation or reducing acidity.

(b) (i) The majority of candidates could use the graph to give the appropriate time. Occasionally candidates were inaccurate in their readings and some candidates tried to round their figures, which was not appropriate in this instance.

(ii) Candidates could generally calculate the average loss of mass per minute. A few candidates used the incorrect value for the total loss of 2 g. Compensation was made to candidates that had identified the incorrect time in part **(i)** but applied this value correctly.

(iii) Some excellent responses were seen. It was pleasing that many candidates referred to kinetic energy and increased frequency of collisions rather than simply stating that **more** collisions occurred.

(c) (i) The majority of candidates could correctly state the meaning of the state symbols.

(ii) It was pleasing to see that many candidates set out their calculations clearly with a number of candidates gaining full credit. The most common error was to not recognise that the number of moles of carbon dioxide and calcium carbonate would be the same.

Question 9

(a) (i) Lead was commonly identified.

(ii) This question proved more challenging. The most common error was to give the incorrect mass number of helium. Candidates need to ensure that they know the difference between the mass and the atomic number. Many candidates recognised that the numbers on both sides of the equation had to balance.

(b) (i) The correct metal of iron was commonly given.

(ii) The correct metal of copper was commonly given.

(iii) Many correct answers were seen. Very occasionally candidates gave the incorrect answer of 3 V due to a mistake in the substitution in the formula.

(c) (i) Most candidates were able to give the two correct quantities required. A few candidates gave the quantities for calculating the volume.

(ii) Candidates should be reminded to read and carry out all the instructions contained in the question as some did not include the term *latent heat of fusion* in their responses. Candidates need to ensure that they know what the term means. In this response, only the stronger candidates

described it as the **energy** needed to overcome the forces of attraction between the particles. A large number of candidates referred to intermolecular bonds, which was not appropriate in this instance.

(iii) Again, the stronger candidates defined this in terms of energy. Some candidates were too vague in their responses and did not specify a mass or a temperature. They need to be clear about the meaning of the terms *thermal capacity* and *specific heat capacity*.

(iv) Many correct answers were seen. The most common error was to use an incorrect formula to give a value of 2.4.

Question 10

(a) (i) Candidates showed good knowledge of the functions of parts of a flower. Sometimes the function of the sepal was too vague. The best responses included the idea of protection of the flower in **bud.**

(ii) Some candidates gave the appearance of the petals in an insect-pollinated plant. Some candidates referred to functional differences rather than differences in appearance.

(b) (i) Candidates must read the question carefully; those that did generally gained full credit, giving two acceptable methods of dispersal. Candidates should ensure that they distinguish between dispersal of seeds and dispersal of pollen. This question specified the dispersal of seeds..

(ii) The idea of colonisation of new areas was implied by the question and so repetition of this was not credited. Many candidates gave good responses including the idea of decreased competition for a named requirement.

(c) Oxygen was commonly identified. The most common incorrect answer given was carbon dioxide. Candidates need to be clear about the gas requirements for photosynthesis and germination.

Question 11

(a) The type of polymerisation needed to form poly(ethene) was well known. Fewer candidates could name the type of polymerisation needed to form nylon.

(b) The vast majority of candidates gained at least partial credit for this question with many being able to identify the alkanes and the alkenes. The most common part where candidates did not gain credit was the identification of the hydrocarbons that produced carbon dioxide and water on complete combustion, with few candidates recognising that all the hydrocarbons would do this.

(c) (i) Only some of the candidates gave the correct reaction of hydrolysis. A wide variety of incorrect responses were seen.

(ii) The correct answer of amino acids was commonly seen.

Question 12

(a) (i) Many correct answers were seen, with the majority of candidates giving the correct value.

(ii) Candidates that showed their working were far more likely to gain credit here. Candidates that gave the incorrect numerical value but showed they had used the correct formula could still gain some of the credit available. Very occasionally the correct numerical figure was given with the incorrect units.

(b) (i) The correct answer of conduction was commonly seen.

(ii) Both convection and radiation were required for the credit here. Radiation was more commonly identified than convection.

(c) (i) Candidates should be aware that the pressure in Pa (pascals) would be the same as in N/m^2. Some candidates tried to manipulate the value given.

(ii) The most common error was incorrect substitution in the formula. Some errors were also seen when candidates attempted to express this in standard form.

Question 13

(a) (i) The definition of mitosis is stated in the syllabus and candidates are expected to recall these definitions. A number of candidates did not refer to **nuclear** division and tried to include the formation of gametes in their definition.

(ii) The answer of asexual reproduction was not commonly seen. Some candidates repeated information earlier in the stem referring to identical cell division rather than stating what this type of cell division would be used for.

(b) The most common error was to suggest that sperm cells always have an **X** chromosome and a **Y** chromosome. Many candidates gained partial credit for recognising that sperm cells were haploid gametes, which contain unpaired chromosomes.

CO-ORDINATED SCIENCES

Paper 0654/43
Theory (Extended)

Key messages

Candidates should note that questions are often worded to guide them to include appropriate subject matter in their answers. They should ensure that their answers refer to any specific terms or ideas indicated in the question. Some phenomena often tested in this examination were not always explained using scientific terminology appropriate to this level of study.

General comments

This key message was illustrated by responses to **Question 2(c)**. Good explanations of the electrical charge of a chloride ion being –1 included the idea that the **number of protons** exceeds the **number of electrons** by one, rather than recalling that a chlorine atom gains an electron in the formation of a chloride ion.

Similarly, good responses to **Question 5(d)** explained the increased reaction rate using the idea that the **rate of collision between copper ions and zinc atoms** increases, rather than just referring to the presence of more copper ions.

Comments on specific questions

Question 1

(a) The questions on the male reproductive system were answered well. Many candidates stated that sperm cells are formed by meiosis. Most knew at least one structure through which sperm cells pass.

(b) The comparison of size and motility of sperm cells and egg cells was carried out well. Some candidates confused the number of egg cells produced in a lifetime with the number available each month.

(c) Some candidates knew the meaning of the term *haploid* often giving information about chromosome numbers. Others stated that haploid is not diploid.

(d) Some knew that fertilisation occurs in the oviduct. Many thought the ovary is the site of fertilisation.

Question 2

(a) (i) The physical states of the Group VII elements were usually predicted accurately. Where errors occurred it was generally the physical state of bromine that was incorrect.

(ii) Most candidates managed to explain the state of bromine without just stating its melting point and boiling point, and used the trend in properties to explain the state of tennessine. Others just used the proximity with iodine in the periodic table as justification.

(b) (i) Group number was used by most to predict the number of valency electrons of tennessine.

(ii) The correct atomic number for tennessine was usually predicted.

(iii) The total number of electrons was often deduced correctly from the atomic number. Some misread the question and gave the number of valency electrons again.

(c) Most candidates knew the charge on a chloride ion. Fewer used the explanation in **(b)(iii)** and compared the numbers of protons and electrons to explain the charge.

Question 3

(a) (i) Data from the speed-time graph was usually used correctly to verify the value for the acceleration given in the question.

(ii) Most candidates knew the relationship between force and acceleration.

(b) The most common mistake in completing the information about the transformer involved the use of the terms *current* and *voltage* in the wrong contexts. Some candidates wrote that copper is used as the material for the core.

Question 4

(a) Most candidates knew that pupil constriction is caused by increased light intensity. The best responses described the contraction of circular muscles. Others confused the mechanism with the control of lens shape.

(b) The importance of pupil reflex was sometimes explained by the need to prevent damage to the retina. Other responses just described the response to light.

(c) The functions of parts of the eye were well known. Some candidates confused the functions of the cornea and lens.

Question 5

(a) Many candidates knew the method of extraction of iron and gold. Many thought that copper, rather than aluminium, is obtained from its oxide by electrolysis.

(b) (i)(ii) Almost all candidates knew the meaning of the term *exothermic* and some could state the energy change. Potential energy was sometimes written instead of chemical energy.

(iii) About half of the candidates realised that the one minute stirring time had to be subtracted from the time at which the reaction ceased.

(c) Many candidates explained that the zinc atoms are oxidised because they lose electrons. Others referred only to copper ions.

(d) Most stated that the reaction rate is higher when the concentration is increased. The best responses explained that because the concentration of copper ions increases, the frequency of collisions increases. Others made vague statements about the number of ions and the number of collisions. Explanations using the concept of copper sulfate particles did not gain credit.

Question 6

(a) (i) Correct reference to an effect of ionising radiation was often made to describe how X-rays are a hazard. Others simply repeated that X-rays are ionising radiation.

(ii) Most candidates knew that lead prevents penetration by X-rays.

(b) (i) A correct meaning for frequency was usually given. Frequency was sometimes confused with wavelength.

(ii) The wave equation was usually rearranged correctly. Errors were caused by manipulation of the units of wavelength.

(c) (i) The description of how oxygen molecules exert a pressure often involved collision with the walls of the cylinder. Some responses used less scientific terminology. The resulting force on the walls was less likely to be mentioned.

(ii) There were some good answers to this calculation with its requirement to manipulate the gas law equation. Many involved the use of the equation P=F / A.

(d) (i) Many candidates knew that α-radiation is ionising and kills cancer cells, rather than describing general properties of α-radiation.

(ii) Some recognised that this specific α-source is suitable because of its relatively short half-life. Many attempted to explain the suitability of α-sources in general.

(iii) Those who knew the correct symbol for an α-particle could usually work out the symbol for the radon nuclide.

Question 7

(a) (i)–(iii) Most candidates made good use of the graph showing the percentage of smokers over a range of age groups to obtain data and describe the trend.

(iv) Most reasons for the decreasing percentage of smokers were valid.

(b) Descriptions of how the gas exchange system removes smoke particles usually included the role of mucus. There were many incorrect suggestions that cilia are responsible for trapping the particles directly.

Question 8

(a) Many candidates stated the correct formula for the sulfur molecule rather than the symbol for the element.

(b) (i) The diagram showing covalent bonding in a hydrogen sulfide molecule was usually drawn correctly, candidates ensuring that the hydrogen atoms had a share in two electrons each, and the sulfur had a share in eight electrons.

(ii) Some candidates explained that sulfur compounds are removed from fuels to avoid the formation of sulfur dioxide which contributes to the production of acid rain. Many concerned themselves with the role of sulfur in the combustion process.

(c) (i) Some candidates were able to quote values for the temperature and pressure and to name the catalyst used in the Contact process. Many knew that the temperature used is relatively high. High pressure was not a response which gained credit.

(ii) Many knew that sulfur trioxide is produced when sulfur dioxide is oxidised.

(iii) When the symbol equation for the oxidation of sulfur dioxide was constructed some candidates could balance it correctly.

Question 9

(a) (i) A few candidates knew that a temperature dependent resistor is called a thermistor.

(ii) The vast majority found the correct value of the resistance of **Z** from the graph.

(iii) This Ohm's law calculation was completed well by many candidates.

(b) The formula for specific heat capacity was usually quoted correctly and the correct value sometimes obtained when the change in temperature was substituted into the formula rather than the final temperature.

(c) The difference in pressure or particle spacing was often used in the description of the difference between a compression and a rarefaction. There seemed to be some confusion between compression and frequency variation.

Question 10

(a) (i) In explaining the appearance of the plant cell, most realised that water had moved into the cell. Some described this movement correctly as osmosis rather than simple diffusion. The better responses recognised that the water potential outside the cell was higher or that the salt concentration was lower than that in the cell. They stated that water flows from higher water potential to lower. There was confusion in some answers about whether the candidate was referring to water concentration or salt concentration. Descriptions of the cell as turgid or swollen were better than just bigger.

(ii) Many candidates knew that an animal cell would burst in water due to the lack of a cell wall. Others thought that animals behave the same as plant cells.

(b) (i) The equation for photosynthesis was quite well known. The respiration equation was sometimes given. There were often mistakes in the formula of glucose.

(ii) Many candidates stated that plant cells in leaves are adapted for photosynthesis by having chloroplasts or chlorophyll. Transparency of cells was not as satisfactory an answer.

Question 11

(a) (i) The alkene with three carbons was often named correctly as propene. Alkanes and other alkenes were suggested.

(ii) Some candidates drew a good diagram of the structure of butene. Many drew butane.

(b) (i) Some recognised the reaction between ethene and bromine as an addition reaction. Cracking and polymerisation were other suggestions.

(ii) Those who knew that the product is colourless sometimes gave a good explanation by stating that bromine forms colourless compounds with alkenes.

(c) Many complete calculations were seen. The relative formula mass was usually verified and step 4 of the calculation was usually carried out correctly. The chemical equation was not always used to find the number of moles of oxygen that reacts, in spite of the advice given in the question.

Question 12

(a) A minority of candidates explained the testing of the composition of a car body based on the magnetic properties of steel. Those that involved destruction or weighing the car were not regarded as *simple* methods.

(b) There were few good explanations of the use of a relay involving the use of a low current circuit to switch a high current. There was often confusion between a relay and an electromagnetic circuit breaker.

(c) The ray diagram was usually drawn well. The angle of reflection and the angle of incidence were sometimes confused.

(d) Some correctly compared how well black and white surfaces absorb heat radiation. Others made absolute statements such as “black surfaces absorb heat”, compared the absorption of visible light or made reference to the “attraction” of radiation.

(e) The two forms of energy gained by the car were usually correct.

(f) (i) Where the correct formula for work was stated the work done by the car engine was usually found.

(ii) There were many correct calculations of the power output. In others the formula for power was not well-known and errors in the units were common.

Question 13

(a) (i) The vast majority of candidates calculated the correct difference in temperature.

(ii) Most knew that greenhouse gases contribute to global warming.

(iii) Many candidates made reference to energy trapped by the greenhouse gases. Few responses included an explanation in terms of the absorption of radiation emitted from the Earth followed by re-radiation in all directions. Many demonstrated the misconception that the ozone layer is involved.

(b) Respiration was usually stated as a biological process that releases carbon dioxide. Decay was also given in some responses.

(c) Candidates usually realised that deforestation reduces oxygen concentration. Some went on to explain this in terms of reduced photosynthesis.

CO-ORDINATED SCIENCES

Paper 0654/51
Practical Test

Key messages

To achieve 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 must be recorded in the Supervisor's report.

General comments

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

The majority of candidates entering this paper 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 every practical test were attempted and there was no evidence of candidates running short of time. The majority of candidates were able to follow instructions correctly and record observations clearly.

The gathering and recording of data presented few problems for any candidates. There was evidence of some candidates not having the use of a calculator.

Comments on specific questions

Question 1

(a) Most pencil drawings of the leaf provided were neatly drawn and included some detail of the leaf. Occasionally candidates ignored the instruction to draw a large diagram and drew diagrams that only occupied a very small space within the box provided for their sketches.

(b) (i) The longest length of the actual leaf was usually recorded, as requested, in millimetres. A minority of candidates, who had obviously confused the millimetre and centimetre graduations on the ruler used, gave answers such as 4 mm, which although obviously incorrect, were not commented upon.

(ii) A significant number of candidates ignored the instruction to draw a straight line on their diagram to indicate the longest length they had measured in **(i)**. Credit could not be awarded for their measured length on the diagram as there were no means of telling which length the candidate had measured.

(iii) The magnification was usually calculated correctly by the candidates. Occasionally, the equation used to calculate the magnification was written upside down.

(c) (i) Few candidates gave a correct and detailed description of the method used to test the leaf for the presence of starch. Most descriptions merely stated that a few drops of iodine should be added to the leaf. Detail such as placing the leaf in hot water and adding alcohol were almost always omitted. Most candidates knew the observation that would give a positive result for the presence of starch.

(ii) Many candidates found it challenging to describe and explain a safety precaution that they would take when carrying out the test for the presence of starch. Few candidates stated that since ethanol is flammable then a water bath and not a naked flame should be used.

(d) Few candidates planned an investigation to find out whether the statement concerning stomata was correct or not. The majority of answers consisted of descriptions of photosynthesis, gas exchange and transpiration, which although sometimes correct, were irrelevant.

Question 2

(a) (i) The temperature of solution **J** was almost always recorded. It was important that there was evidence in the table of results that it had been taken to the nearest 0.5 °C, as requested.

(ii) Most candidates produced a complete table with temperatures recorded at half-minute intervals up to a time of four minutes after solid **H** was added to solution **J**. Tables usually indicated that the temperature of the mixture increased to a maximum value before starting to decrease again.

The descriptions of the appearance of the solid and the solution after the final temperature reading were generally accurate. Credit was awarded when the solution was described as colourless but not for clear or transparent. Candidates should be encouraged to avoid the use of these two words, as a clear or transparent liquid is not necessarily colourless.

(b) (i) Correct answers to this part were uncommon. Candidates usually quoted the maximum temperature reached by the mixture and not the maximum temperature rise of the mixture.

(ii) Candidates found this question challenging. A minority of candidates explained why the maximum temperature rise calculated in **(i)** was only an estimate. Few candidates realised that because the readings were taken at half-minute intervals, the temperature might have been higher between readings.

(iii) A minority of candidates realised that the procedure could be improved, and a better estimate of the maximum temperature reached, by taking readings more frequently.

(c) (i) Most candidates were awarded partial credit by substituting correctly into the given equation. A much smaller number of these candidates gained the additional credit because their answers were given to 2 significant figures, as requested in the stem of the question.

(ii) About half of the candidates realised that the value of the heat energy *E* released during the reaction calculated in **(i)** was less than the actual amount of energy released during the reaction because there would be some heat transfer to the surroundings. Most of these candidates went on to state correctly that this heat loss could be reduced by some form of insulation around the cup, or by adding a lid.

(d) (i) The record of the observations made when ammonia solution was added to some unused solution **J** in a test-tube needed greater detail. Most candidates noted that a blue precipitate was formed, but far fewer stated that the remaining solution was dark blue.

(ii) The cation in solution **J** was usually correctly identified. The evidence given for this correct identification was usually that **J** was a blue solution.

Question 3

(a) The unstretched length l_0 of the spring was usually recorded to the nearest millimetre. Occasionally, candidates measured this length in centimetres and forgot to multiply by 10. This resulted in very small lengths such as 2.1 mm being recorded. Candidates should be encouraged to look at their answers and decide if the recorded length is a sensible one.

(b) The stretched length of the spring when loaded with a mass of 200 g was almost always recorded in the table and the extension produced by this mass calculated correctly and added to the correct box in the table.

(c) (i) Most candidates recorded a sensible value for the time for 20 oscillations of the oscillating mass.

(ii) The table was usually completed with a full set of values of the time for 20 oscillations. In the majority of cases the times recorded correctly displayed an increasing trend as the oscillating mass increased.

(iii) The period of the oscillations T for each mass were usually calculated and recorded correctly.

(iv) Most candidates calculated the value of T^2 correctly. A significant number did not give their answers to 2 significant figures so were not awarded credit.

(d) (i) The standard of graph plotting continues to improve. Most candidates labelled their axes and gave the units and also used a scale that utilised at least half of the given grid. The plots were generally accurate; they could be neater. Many candidates drew large "blobs" to display the plotted points which made it challenging for the Examiner to decide where the centre of the point was. Candidates should be encouraged to use thin crosses, with the intersection of the two cross lines at the point being plotted.

(ii) The judgement of the placing of the line of best-fit was usually very good.

(iii) The calculation of the gradient was challenging for many candidates. They needed to indicate on the graph which coordinates they chose to evaluate the gradient. If a gradient triangle was indicated, it was often too small. Candidates should be encouraged to select points on the graph that are more than half the plotted line apart. This reduces the uncertainty in the value of the gradient calculated and gives a more accurate value.

(iv) The majority of candidates used the given equation correctly with their result from **(iii)** to calculate a value for the acceleration due to gravity. Credit was given for any correctly evaluated value. Where candidates truncated their answers by rounding, the rounding was expected to be correct.

(e) About half the candidates adequately described how parallax errors were avoided when they measured the length of the spring. Viewing perpendicular to the ruler was the expected response, but many candidates gained this credit by stating that the ruler needed to be close to the spring.

(f) This final more challenging part to the question produced only a small number of correct responses. What was required here was a comparison of the value of the acceleration due to gravity obtained from their experiment, with the actual value of $9.8\,m/s^2$ at the Earth's surface. A simple statement such as yes, the values are close enough to be considered equal or no, the values are too far apart to be considered equal, was all that was required.

CO-ORDINATED SCIENCES

Paper 0654/52
Practical Test

Key messages

A straight line through the origin of a graph is evidence of direct proportionality between the physical quantities represented on the axes.

General comments

This paper was finished by all candidates and it was rare to see a part that had not been attempted.

Comments on specific questions

Question 1

The colours observed in the food tests were usually recorded accurately. The response "no change" should be avoided as an alternative to stating the final colour. If the final colours did not match the mark scheme but did match the Supervisor's results, then credit was awarded. It is always essential that a set of Supervisor's results are included with the scripts.

In part **(b)** candidates were very good at identifying the nutrients present. Errors in part **(a)** were carried forward to these conclusions. Most candidates referred to reducing sugars or glucose rather than simple sugars for a positive Benedict's test.

Most candidates correctly suggested the use of test-tube holders for handling hot apparatus in part **(c)**.

For the fat test in part **(d)**, alcohol or ethanol was commonly stated but water was often omitted. If water was included it was usually incorrectly used before the alcohol. The result was well known. Less "white precipitate" responses were seen than in the past.

Part **(e)** was well understood and full credit was awarded in most cases.

Question 2

For part **(a)**, the times were to be recorded to the nearest second. A significant number of candidates used one or two decimal places or the wrong format, e.g. 0:25 for 25 seconds. Generally candidates observed the correct colours, indicating that the practical was well done. Times greater than 60 seconds for magnesium and **L** were credited if there was evidence from the Supervisor that this was correct. Again this emphasises the need for Supervisor's results to be sent with the scripts.

Candidates were able to convert the order of times into an order of rates and all knew that the gas was carbon dioxide.

Despite there being a large number of possibilities for the answer in part **(b)(i)**, relatively few candidates were awarded full credit. The most common response referred to the volume of limewater.

Part **(b)(ii)** was answered well with most candidates referring to averaging.

For the alternative method in **(b)(iii)**, many candidates were able to draw a suitable diagram but few linked time and volume.

For part **(c)** ”white ppt.“ was a common response but fewer candidates recorded that the precipitate disappeared to produce a colourless solution. ”Clear” was not accepted as an alternative for ”colourless”. Most candidates concluded that zinc ions were present.

Finally candidates were good at comparing the order of reactivity of the metals with the order of rates of decomposition if they were the same or if they were inversely related. Candidates were less able to describe the situation where there was no clear relationship between the two.

Question 3

Nearly all candidates were awarded the full credit in part **(a)(i)**. Most candidates were able to calculate the power and correctly round the answer. The units of power were well known. In **(a)(iv)** the credit for current, voltage and power were usually awarded. Many candidates were not consistent in the number of significant figures for the power values. In **(a)(v)** some candidates referred to heating of the wire and others referred to the state of the battery. The description of the effect on the battery proved to be problematic, often confusing voltage, power and energy.

In part **(b)**, axes were labelled and constructed well, as was the plotting of the points. A small number of candidates did not start their graphs at the origin or produced non-linear scales. Generally best-fit lines were well drawn.

Many candidates described the relationship in part **(c)** as positive whereas the relationship was in fact directly proportional for a straight line through the origin, which is what most candidates drew.

CO-ORDINATED SCIENCES

Paper 0654/53
Practical Test

Key messages

The Notes for Qualitative Analysis found at the end of the paper should be used for questions involving the identification of cations and anions.

General comments

This paper was finished by all candidates and it was rare to see a part that had not been attempted.

Comments on specific questions

Question 1

The colours observed in the Benedict's test were usually recorded accurately and candidates were very good at identifying the nutrient present. Most candidates referred to reducing sugars or glucose rather than simple sugars.

Most candidates correctly suggested the use of test-tube holders for handling hot apparatus. A small number chose goggles. In part **(a)(iii)** the most common responses were the volume of the Benedict's solution and the temperature of the water bath. Candidates were less confident in describing how the final colour of the test relates to the concentration of reducing sugar present.

The drawings in part **(b)** were well done and were big enough. Consequently most candidates were awarded full credit in **(b)(i)**. The labelling of the plant parts was less accurate. Common errors were labelling the filament as an anther and labelling the style as the stigma.

For the fat test in part **(c)(i)**, alcohol or ethanol was commonly stated but water was often omitted. If water was included it was usually incorrectly used before the alcohol. The result was well known. Less "white precipitate" responses were seen than in the past.

Candidates realised that the colour of milk would mask the result of the fat test.

Question 2

In part **(a)**, the pieces of apparatus were generally well drawn although not always assembled which would be better. A small number of candidates wrongly used filter paper without a funnel. Labelling of the apparatus was well done and it was rare to see the labelling of the residue and the filtrate muddled. The filtrate and the residue were described accurately.

Parts **(b)(i)** and **(ii)** worked well and produced a large number of accurate answers. Candidates found making conclusions from the observations challenging. Candidates are still relatively weak at making "negative" conclusions, such as "no carbonate" present. The Notes for Qualitative Analysis found at the end of the paper should be used for questions involving the identification of cations and anions because the notes provide a check list of ions to match with observations.

In **(c)(i)** many candidates recorded a blue solution. A small number stated that there were no bubbles. The blue precipitate in **(c)(ii)** was not always seen, perhaps because it was masked by other colours, but nearly all candidates identified copper as the cation present. Very few candidates identified the original substance

as copper oxide. Copper carbonate was the most common wrong compound although this answer was credited a mark if a candidate recorded bubbles with acid which would be characteristic of a carbonate.

Question 3

In part **(a)**, many candidates recorded very low temperatures for the temperature of the hot water in the test-tube. This was accepted if it was similar to the Supervisor's temperature. This emphasises the importance of a copy of the Supervisor's results accompanying the scripts. All candidates generated a full set of results for the first test-tube. Not all candidates produced the correct values for time. Some candidates used minutes, which was accepted if combined with the correct unit.

In part **(b)(i)** candidates found giving a satisfactory explanation challenging. For the next part many candidates were able to give one way of improving accuracy, usually reading the scale at eye level. Few gave two ways.

Candidates repeated the experiment using hotter water in the beaker in **(c)** and generated good sets of results.

Units in **(d)(i)** were often incorrect. Common errors were sec, secs, C, C^{o}.

Temperature falls were calculated accurately and candidates were able to match their conclusion to their results. They did not always discuss this in terms of rate and so were not awarded the full credit in **(e)**.

In part **(f)** candidates often did not answer the question and discussed accuracy rather than a fairer comparison. The most common correct answer involved measuring the volume of water in the test-tube accurately. A few candidates suggested that the initial temperature in the test-tubes should be the same. No credit was given to the suggestion that the two experiments were done at the same time.

CO-ORDINATED SCIENCES

Paper 0654/61
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental technique, to have carried out experiments similar to the ones shown in the paper and be able to draw assembled apparatus. Candidates should have used standard laboratory apparatus and be able to read values from a variety of measuring instruments and record the values to the requested accuracy. Candidates need to read questions carefully so that they answer the question being asked, e.g. **3(d)(iii)** where the values needed for the gradient calculation should have been indicated on the graph.

General comments

Candidates from many centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments and use of a ruler was good. The standard of graph drawing was generally high although candidates need to remember that axes scales should be linear and the axes should cover at least half of the grid. Candidates who chose difficult scales also tended to make errors in plotting. Where candidates are asked to record data in tables, it is important that their additions should be to the same number of significant figures as the rest of the data. Undertaking practical work helps the candidates to interpret and evaluate experimental methods and results.

Comments on specific questions

Question 1

(a) (i) Diagrams were usually of a high standard with many candidates gaining full credit. A small number of diagrams had feathery outlines or an incorrect number of spikes on the leaf.

(ii) Measuring of the line was generally accurate, a significant number of candidates gave the length in centimetres.

(iii) A significant number of candidates omitted to draw the line on their drawing meaning that any length quoted could not gain credit.

(iv) Many candidates calculated the magnification correctly. Inverting the division, subtracting the values and multiplying the values were common incorrect responses.

(b) (i) Many candidates treated the leaf with alcohol and some heated, most knew the test for starch.

(ii) The positive result for the starch test was well known. Blue was a common non-creditworthy response.

Question 2

(a) (i) Candidates found this very difficult, most gave a temperature from the table, 20.5°C was the most common.

(ii) Some candidates subtracted the values correctly. Many gave the highest value from the table, 56.0°C, and some subtracted the first reading from the final reading, 14.5°C

(iii) Few candidates gained credit. Rounding to the nearest 0.5°C was the most common reason given for the value being an estimate.

(iv) Few candidates gained credit. Most answered in terms of a more accurate or precise thermometer being required.

(b) (i) Many candidates performed the calculation correctly but did not give their value to 2 significant figures. Several calculated 3728 and put 37 on the answer line.

(ii) Few candidates gained credit. Many discussed using a more accurate thermometer or using a container made of glass or metal as these absorb more heat.

(c) Many candidates could not recall the test for copper ions. The whole range of quantitative analysis reagents were seen. Of those that used a correct reagent most either gave a colour, although this was often white, or gave precipitate; few gave both. The re-dissolving in aqueous ammonia was rarely seen.

Question 3

(a) The majority of candidates measured the spring correctly. A few candidates gave 50 or 50.5.

(b) Many candidates measured the spring and calculated the extension correctly. 130 and 130.7 were common incorrect responses.

(c) Candidates found squaring *T* difficult, some doubled the value or rounded the value incorrectly.

(d) (i) Whilst generally the graph was quite well executed, many did not start the axes at 0,0 and some had a non-linear scale or scales which did not cover at least half of the grid.

(ii) The line was drawn well by many candidates. Some thought that the line should go through the origin and ignored some points in so doing.

(iii) Many candidates omitted this question. Of those that calculated a gradient many used data points rather than their line or counted squares rather than using graph values. Many did not include evidence on their graph, did not use at least half of the line or inverted the division.

(iv) Most candidates who calculated a gradient went on to attain a value for *g*.

(e) Candidates found this challenging and many omitted the question. Repeat, start the ruler at 0 and hold the spring straight were common non-creditworthy responses.

Question 4

(a) (i) Many candidates read the scales correctly. Reading from the right hand side was a common error.

(ii) The majority of candidates subtracted the two values correctly, a significant number added them.

(iii) Many candidates divided their value in **(a)(ii)** by 30. Some divided by 10 or 20.

(b) Candidates found this difficult. Incorrect responses included: maggots sucking the liquid towards them, soda lime giving off carbon dioxide and the maggots attracting the coloured liquid.

(c) Stronger candidates knew why the clip was closed at the start but many thought it was to keep air or oxygen out of the apparatus. More candidates knew why the clip was opened at the end but many thought it was to let the carbon dioxide out.

(d) Many candidates could name one control variable and fewer named two. Amount of coloured liquid, gauze and soda lime were common non-creditworthy responses**.**

Question 5

(a) Many candidates named a suitable piece of apparatus; beaker was a common incorrect response.

(b) Candidates found the diagram quite difficult, conical flasks or test-tubes and clamp stands were drawn quite often in place of the beaker and tripod. The beaker was frequently empty. Many candidates gave correct labels but sometimes only two.

(c) More able candidates gained credit. The most common response was bubbles stop being formed.

(d) Many candidates labelled the apparatus correctly; far fewer labelled the substances correctly. Copper sulfate crystals in the filter paper and sulfuric acid in the evaporating basin were common.

(e) Candidates found this very difficult. Many thought it was to make a solution or that it hadn't been heated for long enough.

(f) Candidates found this very difficult and a significant number omitted this part of the question. Filtration was the most popular response. Also common was dissolving and repeating steps 5 and 6 or just looking at them for shininess or blueness.

(g) Candidates found this very difficult. Most thought it was to cool, crystallise or harden the crystals. Stopping them melting, shattering or breaking were also seen often.

(h) Candidates found this very difficult and a significant number omitted this part of the question. Copper sulfate, ammonia, hydrochloric acid and sulfuric acid were common responses.

Question 6

(a) (i) Many candidates read the measuring cylinder correctly. 96.6 was a common incorrect response.

(ii) Many candidates recorded the mass correctly. A significant number did not follow the data in the table and so gave the reading to four significant figures.

(b) (i) Most candidates plotted the points correctly, a significant number did not label the axes with both quantity and unit.

(ii) Stronger candidates circled the anomalous point and many omitted this part of the question. A small number circled a point on the line drawn.

(iii) Stronger candidates drew the line of best fit. Many included the anomalous point and so did not draw a straight line or did not consider the number of points above and below the line they drew.

(c) Whilst many candidates gave a value far fewer showed evidence on their graph and so did not gain credit.

(d) Candidates found this very challenging. Many described needing more accurate volumes, being more accurate or repeating with no mention of averaging.

(e) Almost no candidates gained credit and many omitted this question.

(f) Candidates found this very challenging. Contains dissolved carbon dioxide was the most popular response.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper. Candidates should have used standard laboratory apparatus and should be able to read values from a variety of measuring instruments and record the values to the requested accuracy. When planning an experiment, candidates need to consider the steps involved and their sequence.

General comments

Candidates from many centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard, calculations were well executed and food tests were quite well known. The standard of graph drawing was generally high although candidates need to remember to include units on the axes and to draw straight lines with a single line and a ruler. Where candidates are asked to record data in tables, it is important that their additions should be to the same number of significant figures as the rest of the data. Undertaking practical work helps the candidates to interpret and evaluate experimental methods and results.

Comments on specific questions

Question 1

(a) Many candidates gained credit. A significant number gave biuret or iodine.

(b) Food tests were generally well known. Candidates often gave only one nutrient for solution A (usually protein), omitted reducing for the reducing sugar in B and most candidates gave starch for C.

(c) The safety precaution was usually correct. A significant number of candidates did not explain the safety precaution.

(d) Many candidates added ethanol but omitted to add the solution formed to water. Many knew the result expected, precipitate was a common error.

(e) (i) The majority of candidates stated two variables. Some gave answers which were too vague such as volume or heat.

(ii) Candidates found this part more challenging. Many described a degree of colour, e.g. the darker the red the more concentrated or the darker the colour the more concentrated.

Question 2

(a) (i) Candidates found the drawing challenging. Many had bungs in either both tubes or neither or did not have the delivery tube under the level of the limewater. Most labelled the reagents correctly.

(ii) Very few candidates appreciated the problem of ‘suck-back’. Stopping the gas going into the limewater was a common response.

(iii) Most candidates gave the correct reading. Other responses included 00:65, 10:05 and 10:50.

(b) (i) Most candidates knew the test for carbon dioxide gas. A small number gave hydrogen or oxygen.

(ii) Most candidates gave the correct order with a very small number inverting it.

(iii) Candidates found the relationship more challenging and many gave snapshot answers such as the most reactive has a low rate rather than stating the comparative relationship. Some candidates discussed time rather than rate.

(c) Many candidates used a syringe or upturned measuring cylinder in water to collect the gas and measure its volume. Only a few candidates considered time.

Question 3

(a) (i) The unit for current was well known. The unit for power was less well known with J being the most common incorrect response. A significant number omitted the question.

(ii) Most candidates read the meter correctly.

(iii) Most candidates calculated P. A significant number of candidates did not follow the data in the table and so recorded the reading to three significant figures.

(b) Candidates found this difficult. Common incorrect responses included to stop the student being electrocuted, to let the meters reset and to stop the readings adding up each time.

(c) (i) Whilst generally the graph was well executed, units were often omitted from the labels on the axes. A small number had non-linear scales (0 10 20 40 60 80 being common) or scales which did not cover at least half of the grid and some reversed the axes.

(ii) The line was drawn well by many candidates, a few were dot-to-dot lines or not drawn with a ruler.

(d) Many candidates described the relationship correctly. Few explained their answer with many candidates stating the relationship in both parts of the answer.

Question 4

(a) Candidates found this challenging. The two white blood cells were often labelled as W and R. A significant number omitted the question.

(b) (i) Drawings were generally of a high standard. A small number had sketchy outlines or an incorrect number of lobes in the nucleus.

(ii) Most candidates measured the width of the cell and calculated the magnification correctly. Some inverted the division or subtracted the values. Rounding was sometimes incorrect.

(c) (i) Almost all candidates calculated the value correctly.

(ii) Stronger candidates produced detailed descriptions. Resting before taking the pulse was usually omitted. Many described where to find the pulse and how to count the beats for a specified time. Placing a hand over the heart and counting the heart rate was a common non-creditworthy response. Many appreciated the need for repeats.

Question 5

(a) (i) Many candidates drew the solvent below the spots. Many candidates omitted the question.

(ii) Many candidates appreciated that pencil does not dissolve in ethanol. A common response was to mention a line is needed on which to put the spots.

(iii) Candidates found this difficult. Stopping substances from entering the beaker was the most common response.

(b)(i) Many candidates worked out the number of colours correctly. Some stated that all four colours need to be mixed to make black.

(ii) Many candidates gained full credit. Sometimes the explanation was missing.

(c) (i) Candidates found this very difficult. Inks dissolve in water or they dissolve faster in ethanol were common responses.

(ii) Candidates found the idea of better separation challenging. More accurate was a common response.

(d) Running a chromatogram with the sweet and the red dye was well answered. Many candidates melted the sweet rather than dissolving it.

Question 6

(a) Candidates found this very difficult. Many used the ruler to measure 50 cm, marked this point and started the ruler again from the point and repeated until the top of the stairs was reached.

(b) (i) Many candidates gained credit, running out of energy was a common response.

(ii) Most candidates calculated the average correctly, some then gave the answer to 4 significant figures.

(c) (i) Most candidates read the scale correctly, 430 N was sometimes seen.

(ii) Candidates found this very difficult. Moving causing changing the persons weight or to get an accurate answer were common responses.

(iii) Candidates found this difficult. To get an accurate reading was the most common response. .

(d) (i) Most candidates calculated the value correctly.

(ii) Most candidates calculated the value correctly, some rounded the value incorrectly

(e) Most candidates knew the power was less and some gave a correct explanation. Having less energy, shorter legs or needing to train more often were common responses.

CO-ORDINATED SCIENCES

Paper 0654/63
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques, to have carried out experiments similar to the ones shown in the paper and to be able to draw apparatus. Candidates should have used standard laboratory apparatus and be able to read values from a variety of measuring instruments and record the values to the requested accuracy. Candidates should have performed identification tests on the range of substances detailed in the specification.

General comments

Candidates from some centres demonstrated good understanding of practical knowledge. The standard of biological drawings was quite high. The standard of graph drawing was also good. Where candidates are asked to record data in tables it is important that their additions should be to the same number of significant figures as the rest of the data. Undertaking practical work helps the candidates to state observations and to interpret and evaluate experimental methods, techniques and results.

Comments on specific questions

Question 1

(a) (i) Drawings were generally of a high standard. Some had sketchy outlines particularly the petals or the style was not clearly visible at the top of the stigma. A few were smaller than the original.

(ii) Most candidates labelled the flower parts correctly. Some responses labelled the filament as the anther or labelled the anther or the style as the stigma

(b) (i) Many candidates added ethanol but omitted to add the solution formed to water. Many candidates knew the result expected, although precipitate was a common error. A few candidates described reducing sugar or protein tests.

(ii) Many candidates appreciated that milk is the same colour as the positive test result. Presence of protein or calcium or the milk clotting was seen quite often.

Question 2

(a) (i) Generally the standard of drawing was quite high. Some omitted the filter paper from the funnel or had a hole in the filter paper and often the test-tube was replaced by a beaker. The labelling was usually correct.

(ii) Many candidates gained credit. Cleaner and bacteria free were common non-creditworthy responses.

(b) Candidates found this part difficult. Copper was a common response.

(c) (i) Few candidates appreciated that an observation was required, ammonia given off was not creditworthy. Most candidates gave correct observations for litmus.

(ii) Many candidates appreciated that the reagent added would also give ammonia gas.

(iii) Candidates found this quite challenging. Chloride and sulfate were common responses for the nitric acid test and chloride was common for the barium nitrate test.

Question 3

(a) (i) Most candidates read the thermometer correctly. Some responses gave 61.5 or 60.3.

(ii) Candidates found this difficult. Most described letting the temperature of the water settle.

(iii) Candidates found this very difficult. Common responses included using the same starting temperature, using the same volume of water and repeating the experiment.

(b) (i) Most candidates gave the correct units. Degrees and F were seen occasionally.

(ii) Most candidates calculated the decreases in temperature correctly. Occasionally 32.5 or 23.5 were seen.

(c) Many candidates deduced the relationship between the rate of cooling and the surrounding temperature. Reference to the information or data was quite often missing.

(d) Candidates found this very difficult. Some suggested an improvement, the explanation was often omitted. Common responses included repeating the experiment, using a more accurate thermometer and ensuring the same room temperature.

Question 4

(a) (i) Almost all candidates counted the number of woodlice correctly.

(ii) Most candidates calculated the average correctly and many rounded the value to the nearest whole number of woodlice.

(b) The bar charts drawn were of a very high standard. A small number of candidates either omitted to label the axes or used less than half of the grid.

(c) (i) Almost all candidates gave the correct section.

(ii) Most candidates gained credit. A small number put them all in the same section, often damp and dark.

(iii) Most candidates gave one correct improvement and many gave two. Common non-creditworthy responses included: use a control, same room temperature, control the amount of dampness/light, at the same time of day and count at times during the 15 minutes.

Question 5

(a) (i) Candidates found this difficult. Of those that gave cobalt chloride many gave the reverse colour change, many checked melting point or boiling point. Copper chloride was seen quite often.

(ii) Many candidates gained credit. Cooling of the gases and condensing the hydrocarbon were common responses.

(b) (i) Many candidates omitted this question. Blocking off the exit on the bottle was a common incorrect response.

(ii) The test for carbon dioxide was well known.

(c) Candidates found this very difficult and many did not provide a response. Most responses agreed with the student, explaining that the tests proved that carbon dioxide and water were present. Few candidates considered the limitations of the experiment.

(d) Candidates found this very difficult. The water diluting the limewater and so stopping it testing for carbon dioxide was a very common response.

(e) Some candidates gained credit for the idea of a control. Cleaning the apparatus and removing impurities were common responses. Many candidates omitted this question.

(f) The identity of the black solid was well known. Common incorrect responses included carbon monoxide, carbon dioxide, hydrogen and tar.

Question 6

(a) Many candidates measured the angle correctly. 30° was the most common incorrect response.

(b) Most candidates measured the line correctly.

(c) (i) Generally the standard of graph drawing was good. A significant number of candidates omitted to label the axes or used less than half of the grid.

(ii) The line was drawn well by many candidates. Some responses had all of the points which did not lie on the line itself to one side of the line.

(d) Whilst many candidates used their graph correctly, many omitted to include evidence on their graph and so could not gain credit. Some misread their scale on the *x*-axis, often reading, for example, 43 instead of 46.

(e) (i) Few candidates gained credit and many omitted the question. Making the measuring easier was a common response.

(ii) Candidates found this difficult and many omitted the question. Changing or increasing the sugar concentration was a common response.

(f) Many candidates gained credit. A common response was that the change causes the sugar concentration to be too high.